# Analysis of the Effect of Production on Investment in Digging - Loading and Transport Equipment PT. Y in Block 8 of PT X Limestone Mining, South Sulawesi Province

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**Abstract** Cement production requires raw materials consisting of primary raw materials, namely limestone with a percentage of 85%, and clay with a percentage of 13%. The large demand for limestone requires PT. One of the contractors carrying out this mining is PT Y in block 8. The mining carried out by PT Y in block eight has a target of 74,000 tons in October. From field observations, there were obstacles, namely equipment incompatibility, which affected production achievements in October. From the analysis that has been carried out, it is obtained that the match factor is 1.275 so that transportation facilities are reduced from 6 means of transport to 5 means of transport. From productivity calculations, the results obtained are that if you use a 1:6 transport fleet, the production that can be done in one day is 2,823.08 tons, whereas if you use a 1:5 fleet, the production that can be produced in one day. is 2,900,704 tons. Total operational costs for a 1:6 fleet IDR 4,580,431,703.68. Meanwhile, if you use a 1:5 fleet, it is IDR 4,246,980,096.24. Using a 1:5 fleet is much more profitable than using a 1:6 fleet.

**Keyword**: *productivity, capital cost, operasional cost, investment, sensitivity, limestone.*

## 1. Introduction

In the production of cement, raw materials are needed consisting of primary raw materials, namely limestone with a percentage of 85%, and clay as much as 13%, besides that, secondary raw materials are also needed as correction materials derived from tuff, silica, and gypsum with a total percentage of 2% (Phillip Alsop, 2011)[1].

To fulfil the need for the use of limestone, PT X requests the services of contractors to carry out its mining. One of the contractors that do the mining is PT Y which has a production target to meet the needs of the crusher every month.

PT Y mining in block eight has a target of 74,000 tonnes per month. From the data that was produced during 2023 from January to October, the actual only a few months that reached the production target as planned. From observations in the field, there is a queue on the conveyance at the block 8 limestone mining location, where this queue results in waiting time on the conveyance so that production is not running optimally. Therefore, it is necessary to analyse the compatibility of digging - loading equipment and transport equipment to achieve optimal production.

At PT X, the payment of mining wages for contractor services is paid based on the amount of tonnage that can be transported within one month. Therefore, the more production, the more income received each month. The revenue generated affects the investment in heavy equipment used in mining activities, therefore in this study, investment analysis was carried out using the net present value method, payback period, and profitability index.

# 2. Literature View

## 2.1 Technical Studies

### *2.1.1 Cycle Time*

Every tool that works has the ability to move material in each cycle. The work cycle is the process of movement of a tool from its initial movement until it returns to that initial movement. The time required to carry out one cycle of digging, loading and transporting work activities is called cycle time. The division is based on the system, cycle time is divided into digging - loading equipment cycle time and transportation equipment cycle time (Mahesa Tomara et al., 2019)[2].

#### *a. Digging Tool Circulation Time – Loading*

The circulation time of the digging - loading equipment is the cycle time for loading material into the vessel truck starting from digging until dumping the material and returning to its original position with the bucket empty. The formula for calculating circulation time (Mahesa Tomara et al., 2019) is as follows:

$$Ctm = t1 + t2 + t3 + t4$$

Where:
Ctm : Total loading cycle turnaround time (seconds)
t1 : Time to excavate material (seconds)
t2 : Time for charged swing (seconds)
t3 : Time for material to spill (seconds)
t4 : Time for empty swing (seconds)

#### *b. Transport Equipment Circulation Time*

Transport equipment circulation time is the time of one transport cycle starting from the time for loading the material, the time for transporting the material to the dumping location, the time for returning, and the time for taking position. The formula for calculating the cycle time for transport equipment (Mahesa Tomara et al., 2019) is:

$$\text{CTa} = ta1 + ta2 + ta3 + ta4 + t5$$

Where:
Cta : Transport cycle time (seconds)
ta1 : Loading time (seconds)
ta2 : Hauling time (seconds)
ta3 : Dumping time (seconds)
ta4 : Return time (seconds)
ta5 : Spotting time (seconds)

### 2.1.2 *Match Factor Analysis*

A harmonious working relationship between digging-loading equipment and transportation equipment can occur, if the production of digging-loading equipment must be in accordance with the production of transportation equipment. The compatibility factor for digging-loading equipment and transportation equipment is based on the production of digging-loading equipment and transportation equipment which is expressed in the compatibility factor (Oemiati et al., 2020)[3]. Match factor can be calculated using the following formula:

$$MF = \frac{n \times Ctm \times Na}{Cta \times Nm}$$

Where:
MF = match factor
Na = number of means of transportation
Nm = number of loading devices
N = number of fillings per transport vehicle
Cta = cycle time of transportation equipment
Ctm = loading tool cycle time
The match factor obtained means:

a) MF < 1
1) Production of transportation equipment is smaller than production of loading equipment
2) Transport vehicle waiting time = 0
3) Transport equipment working factor = 100%
4) Excavator work factor - load (Fkm) = MF × 100%
5) Excavator waiting time – loading

$$\text{Wtm} = \frac{Cta \times Nm}{Na} - Ctm \times n$$

b) MF > 1
1) Production of transportation equipment is greater than production of loading equipment
2) Excavator waiting time - load = 0
3) Excavator work factor - load = 100%
4) Transport equipment working factor = 100%

$$\text{Fka} = \frac{1}{MF} \times 100\%$$

5) Waiting time for transportation

$$\text{Wta} = \frac{Ctm \times Na}{Nm} - Cta$$

c) MF = 1
1) Production of transportation equipment is the same as production of loading equipment.
2) Excavator waiting time - loading.
3) Waiting time for transportation equipment.
4) The working factor of the digging - loading equipment is the same as the working factor of the transportation equipment.

### *2.1.3 Correction Factor*

#### *a. Bucket Fill Factor*

"Fillability" or "fill-factor" is another factor that must be taken into account when estimating production per cycle. This refers to the ratio of the volume of loose rock contained in the bucket to the rated bucket capacity (Hustrulid et al., 2013).

$$Fillability = \frac{loose\ rock\ (yd^3)}{bucket\ fill\ capacity\ (yd^3)}$$

When filling, it must be ensured that the filling capacity or filling factor and the measured bucket capacity go together. For excavators, the rated bucket capacity (nominal bucket capacity) is the hit capacity.

#### *b. Swell Factor*

In a mine, the material to be loaded into the bucket must first be dumped from the "in situ" or "bank" position. In mining, this is often done by blasting. Assuming that the material occupies a volume of 1 yd3 in place (denoted as 1 bank cubic yard, or 1 bcy), the same amount of material is expected to occupy a larger volume in the loose condition.

Due to the presence of empty space (air) between the pieces, the weight of one cubic yard of loose material (one lcy) will be less than the weight of one bcy (Hustrulid et al., 2013). The loose condition in the material is known as swell, with the following formulation:

$$Swell = \frac{bank\ weight\ per\ unit\ volume}{loos\ weight\ per\ unit\ volume}$$

#### *c. Work Efficiency*

Effective working time is time that can be used to carry out production operations without any obstacles that can be overcome or obstacles that cannot be overcome. This work efficiency will affect the production capability of a tool. Calculation of effective working time can be calculated using the following formula (Oemiati et al., 2020):

$$We = Wt - (Wtd + Whd)$$

Where :
We = effective working time (minutes)
Wt = available working time (minutes)
Whd = time the obstacle can be avoided (minutes)
Wtd = time the obstacle cannot be avoided (minutes)

After calculating effective working time, work efficiency is obtained using the following formula:

$$Ek = \frac{We}{Wt} \times 100\%$$

### *2.1.4 Digging Equipment Productivity – Loading and Transport Equipment*

The amount of production from loading and conveying equipment can be calculated by multiplying the bucket capacity, the number of trips per hour and a correction factor. The corrosion factor consists of work efficiency and fill factor. Productivity calculations can be calculated using the following formula:

$$Qm = \left(\frac{60}{Ctm}\right) \times Cb \times Ff \times Sf \times E$$

Where:
Qm: Productivity of loading equipment (Bcm/hour)
CTM: loading tool cycle time (minutes)
Cb: bucket capacity (m3)
Ff: Fill factor (%)
SF: Swell factors
E: Work efficiency (%)

$$Qa = Na \times \left(\frac{60}{Cta}\right) \times Cb \times Ff \times Sf \times E \quad \ldots\ldots\ldots(8)$$

Information:
Qa: Productivity of conveyance (Bcm/hour)
Cta: cycle time of transportation equipment (minutes)
Cb: bucket capacity (m3)
Ff: Fill factor (%)
SF: Swell factors
E: Work efficiency (%)

## 2.2 Economic Studies

### *2.2.1 Owning Cost*

#### *a. Depreciation*

Depreciation is the depreciation or decline in the value of an asset over time. As is known, the definition of assets includes current assets and fixed assets which are generally physical in nature, such as buildings, machines or equipment, fleet, etc. Therefore, the assets referred to in this research are fixed assets, (Giatman, M 2011; 143) [4]. Depreciation can be calculated using the following formula:

$$Depreciation = \frac{Tool\ price - Trade\ in\ Value}{life\ time(hours) \times Annual\ Use\ in\ Hours}$$

#### *b. Interest, Taxes, and Insurance*

Giatman, M (2011; 39) states that "interest is the amount of money paid as a result of using previously borrowed money". Capital interest must be included in calculating the cost of ownership, capital interest does not only apply to companies that purchase equipment using a credit system, but can also come from their own money which is

considered a loan, the current repayment period is usually more than two years (Z Zaenal & S Widayati, 2019)[5]. Interest, taxes and insurance calculations are calculated using the following equation:

$$\text{Interest + Tax + Insurance} = \frac{Factor \times equipment\ price\ per\ year}{number\ of\ uses\ per\ year}$$

$$\text{Factor} = \frac{1-(n-1)\times(1-r)}{2\times n}$$

Where:
n = economic life (life time) of the tool (years)
r = tool residual value (%)

### *2.2.2 Operating Costs*

#### *a. Fuel Costs*

Fuel and lubricant requirements per hour are different for each tool or brand of machine. The fuel consumption of the equipment depends on the size of the engine power used, as well as whether the terrain conditions are light or heavy. This data can usually be obtained from the equipment manufacturer or equipment dealer concerned or based on data obtained from the field. Equipment manufacturers usually provide fuel consumption estimates according to the equipment's engine power expressed in liters/hour or gallons/hour (Z Zaenal & S Widayati, 2019) [5]. Calculation of fuel costs can be calculated using the following equation:

$$Fuel\ Price = need\frac{BBM}{jam} \times fuel\ price/liter$$

#### *b. Filter Costs*

For the needs of these materials, such as fuel needs, each large tool's hourly requirements differ according to work conditions. Filter cost calculations can be calculated using the following equation:

$$\text{Filter Costs / hour} = \frac{total\ filter \times filter\ price}{Filter\ useful\ life\ (hours)}$$

#### *c. Tire Price*

The tire life of the equipment is greatly influenced by the working field in addition to speed and air pressure. Apart from that, the quality of the tires used also has an influence. Tire life is usually estimated according to the conditions of the working field (Z Zaenal & S Widayati, 2019)[5]. Tire costs can be calculated using the following equation:

$$Tire\ Price = \frac{Tire\ price\ (rupiah)}{tire\ life\ (hours)}$$

## 2.3 Investment Analysis

### 2.3.1 *Net Present Value*

Net present value (NPV) is a method of calculating net value at the present time. The present assumption explains that the initial time of the calculation coincides with the time the evaluation was carried out or in the zeroyear period (0) in the cash flow calculation. NPV can be calculated using the following equation:

$$\text{NPV} = Total\ Present\ Value - initial\ investment \quad \ldots\ldots(13)$$

The following is the meaning of the NPV value for the investment decisions that will be made:

1) NPV > 0, then the project is economical to run
2) NPV < 0, then the project is not worth running because it is not economical
3) NPV = 0, then the project can be run or not run

### 2.3.2 *Payback Period*

Payback period analysis basically aims to find out how long (period 0) the investment carried out can be returned when a break event point occurs, determined by calculating from a negative value to a positive value. The payback period can be calculated using the following equation:

$$Payback\ period = n + \frac{a}{b} \times 1\ year$$

n = the last year where the total cash flow still does not cover the initial investment.
a = total cash flow in year n+1.
b = cumulative amount of cash flow in the nth year.

### 2.3.3 *Profitability Index*

The profitability index (PI) method calculates the comparison between the value of future net cash flows and the current investment value. Investment can be said to be feasible when the PI value is greater than 1, the greater the PI value, the more feasible the investment (Sidauruk et al., 2018) [6]. Profitability index (PI) is calculated using the following formula:

$$\text{PI} = \frac{present\ value}{investment}$$

## 2.4 Sensitivity Analysis

Sensitivity analysis is a technique used to analyze a parameter or variable regarding a conclusion or overall decision. In a sensitivity or sensitivity analysis, the extent to which changes in production cost parameters and product selling prices affect the feasibility of a business

will be studied. In this case, the sensitivity of the feasibility assessment that has been decided will be evaluated to changes in parameters that influence feasibility (Romansyah et al., 2015).

## 3. Research Methods

This research is included in the type of quantitative research, because this research leads to applied research. Applied research is research that has the aim of solving practical problems or producing new products. The results of this research can be used directly by companies or interested people.

This research uses primary data and secondary data which are then developed according to the research objectives. Primary data is data obtained directly by the party who needs the data, while secondary data is data that is not obtained directly by the party who needs the data. The primary data that will be taken in this research is excavator cycle time and dump truck cycle time data, while the secondary data taken in this research is equipment price data; trade in value; working time; average investment; interest, taxes, and insurance; fuel requirements; fuel prices; oil, filter and grease requirements; oil prices; tire prices; number of heavy equipment units; and repair costs.

## 4. Results and Discussion

### 4.1 Technical Studies

*a. Fleet 1:6*

1) Match Factor

$$MF = \frac{Na \times n \times Ctm}{Nm \times Cta} = \frac{6 \times 6 \times 30{,}61}{1 \times 931{,}30} = 1{,}275$$

The match factor value means that there is a queue at the conveyance, so that there is a waiting time for the conveyance with the calculation, namely:

*2) Transport Equipment Waiting Time*

$$Wta = \frac{Ctm \times Na}{Nm} - Cta = \frac{3{,}189 \times 6}{1} - 15{,}522 = 3{,}616 \text{ minute}$$

*3) Digging Equipment Productivity*

In calculating the productivity of digging tools there is no waiting time for digging tools, so there is no additional cycle time so that fleet 1:6 and fleet 1:5 have the same productivity of digging tools with the following calculation:

$$Q_m = \frac{60}{Ctm} \times KB \times SF \times Ff \times E = \frac{60}{0{,}51} \times 2{,}1\ m^3 \times 62\% \times 80{,}12\% \times 76{,}69\% = 93{,}390 \frac{BCM}{month} \times 2{,}6 \frac{ton}{m^3} \times 11{,}08\ hour = 2.979{,}368 \text{ tonnes/day}$$

*4) Productivity of Transport Equipment*

In the 1:6 fleet, there is a queue for transport equipment, so there is waiting time for transport equipment, so the cycle time is increased. Calculation of conveyance productivity is as follows:

$$Q_a = Na \times \left(\frac{60}{Cta+Wta}\right) \times KB \times n \times Ff \times Sf \times E = 6 \times \left(\frac{60}{15{,}56+3{,}616\ minute}\right) \times 2{,}1 \times 6 \times 80{,}12\% \times 62\% \times 76{,}36\% = 89{,}23 \frac{BCM}{hour} \times 2{,}6 \frac{ton}{m^3} \times 11{,}88\ jam = 2.834{,}702 \text{ tonnes/day}$$

*b. Fleet 1:5*

*1) Match Factor*

Because in the 1:6 fleet there is equipment incompatibility, a reduction in transportation equipment is carried out by calculating the compatibility of digging equipment and transportation equipment as follows:

$$MF = \frac{Na \times n \times Ctm}{Nm \times Cta} = \frac{5 \times 1 \times 30{,}61}{1 \times 931{,}30} = 1{,}0$$

*2) Productivity of Transport Equipment*

The productivity of transportation equipment using a 1:5 fleet means there are no queues, so there is no waiting time for digging equipment or transportation equipment. Calculation of the productivity of 1:5 fleet transportation equipment is as follows:

$$Q_a = Na \times \left(\frac{60}{Cta+Wta}\right) \times Kb \times n \times Ff \times Sf \times E = 6 \times \left(\frac{60}{15{,}56\ minute}\right) \times 2{,}1 \times 6 \times 80{,}12\% \times 62\% \times 76{,}69\% = 91{,}688 \frac{BCM}{month} \times 2{,}6 \frac{ton}{m^3} \times 11{,}88\ hour = 2.912{,}646 \text{ tonnes/day}$$

## 4.2 Economic Studies

### *4.2.1 Owning Cost*

Cost of ownership consists of the equipment price, residual value, and average investment. From the calculations that have been carried out, the ownership cost for a 1:6 fleet is Rp. 1,830,380,016.12/year, whereas if you use a 1:5 fleet, the ownership cost is Rp. 1,585,995,518.3.

**Table 1.** Owning Cost

| Year | Owning Cost | |
|---|---|---|
| | *Fleet* 1:6 | *Fleet* 1:5 |
| 1 | Rp 1.830.380.016,12 | Rp 1.585.995.518,37 |
| 2 | Rp 1.830.380.016,12 | Rp 1.585.995.518,37 |
| 3 | Rp 1.830.380.016,12 | Rp 1.585.995.518,37 |
| 4 | Rp 1.830.380.016,12 | Rp 1.585.995.518,37 |
| 5 | Rp 1.830.380.016,12 | Rp 1.585.995.518,37 |
| **Total** | **Rp 9.151.900.080,59** | **Rp 7.929.977.591,84** |

### *4.2.2 Operational Cost*

Operational costs at PT Y consist of oil costs, repair costs and operator salaries. Meanwhile, fuel costs are not calculated because they are paid by PT X as the owner. From the calculations that have been carried out, it is found that the cost of oil in five years when using a 1:6 fleet is IDR. 1,200,551,748.28. Meanwhile, if you use a 1:5 fleet, the cost in five years will be IDR 1,096,612,710.31.

**Table 2.** Operational Cost

| Year | Operational Cost | |
|---|---|---|
| | *Fleet* 1:6 | *Fleet* 1:5 |
| 1 | Rp 2.765.182.435,07 | Rp 2.534.271.026,54 |
| 2 | Rp 2.765.182.435,07 | Rp 2.534.271.026,54 |
| 3 | Rp 2.765.182.435,07 | Rp 2.534.271.026,54 |
| 4 | Rp 2.765.182.435,07 | Rp 2.534.271.026,54 |
| 5 | Rp 2.765.182.435,07 | Rp 2.534.271.026,54 |
| **Total** | **Rp 13.825.912.175,36** | **Rp 12.671.355.132,72** |

### *4.2.3 Cash In*

Cash in can be interpreted as annual income which is calculated by multiplying annual production by the price of mining services per ton, which is IDR. 6,100,-, Cash In per year then multiplied by the compound interest factor, so that the cash in present value each year. The results of these calculations can be seen in the following table:

**Table 3.** Cash in Fleet 1:6

| *Fleet* 1:6 | | |
|---|---|---|
| Year | Production (tons/year) | Cash In |
| 1 | 894.916,35 | Rp5.458.989.750,64 |
| 2 | 894.916,35 | Rp5.458.989.750,64 |
| 3 | 894.916,35 | Rp5.458.989.750,64 |
| 4 | 894.916,35 | Rp5.458.989.750,64 |
| 5 | 894.916,35 | Rp5.458.989.750,64 |
| **Total** | **4.474.581,76** | **Rp27.294.948.753,21** |

**Table 4.** Cash in Fleet 1:5

| *Fleet* 1:5 | | |
|---|---|---|
| Year | Production (tons/year) | Cash In |
| 1 | 919.523,32 | Rp5.609.092.246,74 |
| 2 | 919.523,32 | Rp5.609.092.246,74 |
| 3 | 919.523,32 | Rp5.609.092.246,74 |
| 4 | 919.523,32 | Rp5.609.092.246,74 |
| 5 | 919.523,32 | Rp5.609.092.246,74 |
| **Total** | **4.597.616,60** | **Rp28.045.461.233,68** |

### *4.2.4 Cash Out*

Cash out is the sum of ownership costs and operational costs that must be incurred every time you mine a ton of limestone which is obtained by dividing cash out per hour divided by hourly production. From the calculation results, the annual cash out if you use a 1:6 fleet is IDR 4,580,431,703.68, whereas if you use a 1:5 fleet the annual cash out is IDR 4,246,980,096.24. For more details, annual cash out can be seen in the following table.

**Table 5.** Cash Out Fleet 1:6

| *Fleet* 1:6 | |
|---|---|
| Year | Total *Cash Out* |
| 1 | Rp 4.580.431.703,68 |
| 2 | Rp 4.580.431.703,68 |
| 3 | Rp 4.580.431.703,68 |
| 4 | Rp 4.580.431.703,68 |
| 5 | Rp 4.580.431.703,68 |
| **Total** | **Rp 22.902.158.518,38** |

**Table 6.** Cash Out Fleet 1:5

| *Fleet* 1:5 | |
|---|---|
| Year | Total *Cash Out* |
| 1 | Rp 4.246.980.096,24 |
| 2 | Rp 4.246.980.096,24 |
| 3 | Rp 4.246.980.096,24 |
| 4 | Rp 4.246.980.096,24 |
| 5 | Rp 4.246.980.096,24 |
| **Total** | **Rp 21.234.900.481,20** |

## 4.3 Investment Analysis

*a. Interest Factor*

The interest used in this calculation is 11% compound interest, where 11% compound interest is as follows:

**Table 7.** Compound Interest Factor

| i | P/F | P/A |
|---|---|---|
| 11% | 0.901 | 0.901 |
| | 0.812 | 1.713 |
| | 0.731 | 2.444 |
| | 0.659 | 3.102 |
| | 0.593 | 3.696 |

*Source: Engineering Economics Book, M. Giatman*

*b. Trade in Value*

The residual value determined by the company is 27% of the equipment purchase price. When using 1 digging - loading equipment and 5 transportation equipment, a residual value of IDR is obtained. 1,984,500,000.00. Meanwhile, if you use 1 digging and loading equipment and 6 transportation equipment, you get a residual value of IDR 1,721,250,000.00.

*c. Net Present Value*

From the investment analysis calculations, the NPV value obtained if you use a 1:6 fleet is IDR 4,243,432,621.26, whereas if you use a 1:5 fleet the NPV value will be IDR 12,297,223,842.85. The profit obtained if you use 5 means of transportation is IDR 8,053,791,221.59 with a profit percentage of 65% from using fleet 6. The results of the net present value calculation can be seen in the following table:

**Table 8.** Net Present Value

| Year | NPV | |
|---|---|---|
| | Fleet 1:6 | Fleet 1:5 |
| 0 | -Rp 7.350.000.000,00 | -Rp 6.375.000.000,00 |
| 1 | Rp 791.493.823,07 | Rp 1.341.284.563,60 |
| 2 | Rp 1.504.550.862,26 | Rp 2.549.648.257,36 |
| 3 | Rp 2.146.945.477,74 | Rp 3.638.265.699,93 |
| 4 | Rp 2.725.678.898,58 | Rp 4.619.001.343,32 |
| 5 | Rp 4.424.763.559,61 | Rp 6.524.023.978,64 |
| **NPV** | **Rp 4.243.432.621,26** | **Rp 12.297.223.842,85** |

*d. Payback Period*

The payback period is used to determine the year of capital payback. The payback period is positive when the value is no more than the previously determined life of the equipment. From the calculations that have been carried out, if you use a 1:6 fleet, the payback period will be 4.06 years, whereas if you use a 1:5 fleet, the payback period will be 2.68 years. This means that if you use 5 means of transportation, the payback time is 1.4 years faster.

*Fleet* 1:6

$$\text{PBP} = n + \frac{a}{b} \times 1\ year$$

$$\text{PBP} = 4 + \frac{Rp.181.330.938,35}{Rp.3.172.631.303,91} \times 1\ year$$

$$\text{PBP} = 4{,}06\ year$$

*Fleet* 1:5

$$\text{PBP} = n + \frac{a}{b} \times 1\ year$$

$$\text{PBP} = 2 + \frac{Rp.2.484.067.179,04}{Rp.3.638.265.699,93} \times 1\ year$$

$$\text{PBP} = 2{,}68\ year$$

*e. Profitabilitas Index*

The PI value is considered profitable if it is greater than 1, meaning that a project is more profitable if it has the largest profitability index value and is the best way to compare projects that are more profitable. Based on calculations that have been carried out, the 1:6 fleet has a PI value of 0.58 and the 1:5 fleet has a PI value of 1.89.

$$PI_6 = \frac{Present\ Value}{Investment}$$

$$PI_6 = \frac{Rp.4.243.432.621,26}{Rp.7.350.000.000,00}$$

$$PI_6 = 0{,}58$$

*Fleet 1:5*

$$PI_5 = \frac{Present\ Value}{Investment}$$

$$PI_5 = \frac{Rp.12.297.223.842,85}{Rp.6.375.000.000,00}$$

$$PI_5 = 1{,}93$$

**Table 9.** *Cash Flow Fleet* 1:6

| CASHFLOW REPORT ON LOADING AND HAULING ACTIVITIES IN BLOCK 8 LIMESTONE MINING | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No | Information | | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
| Initial Cash Flow | | | | | | | | |
| Equipment Purchase Costs | | | | | | | | |
| 1 | UD Quester CWE 370 | 6 | Rp 5.850.000.000,00 | | | | | |
| 2 | Komatsu PC 400-8 Lc | 1 | Rp 1.500.000.000,00 | | | | | |
| Total Initial Cash Flow | | | Rp 7.350.000.000,00 | | | | | |
| Owning Cost | | | | | | | | |
| 1 | Depreciation | Rp/ton | | Rp 1.717.054.424,13 | Rp 1.717.054.424,13 | Rp 1.717.054.424,13 | Rp 1.717.054.424,13 | Rp 1.717.054.424,13 |
| 2 | Average Investment | Rp/ton | | Rp 98.194.844,48 | Rp 98.194.844,48 | Rp 98.194.844,48 | Rp 98.194.844,48 | Rp 98.194.844,48 |
| Total Owning Cost | | | | Rp 1.815.249.268,60 | Rp 1.815.249.268,60 | Rp 1.815.249.268,60 | Rp 1.815.249.268,60 | Rp 1.815.249.268,60 |
| Operational Cost | | | | | | | | |
| 1 | Oil Cost | Rp/ton | | Rp 240.110.349,66 | Rp 240.110.349,66 | Rp 240.110.349,66 | Rp 240.110.349,66 | Rp 240.110.349,66 |
| 2 | Maintanance Cost | Rp/ton | | Rp 1.717.054.424,13 | Rp 1.717.054.424,13 | Rp 1.717.054.424,13 | Rp 1.717.054.424,13 | Rp 1.717.054.424,13 |
| 3 | Employee Salary | Rp/ton | | Rp 808.017.661,29 | Rp 808.017.661,29 | Rp 808.017.661,29 | Rp 808.017.661,29 | Rp 808.017.661,29 |
| Total Operational Cost | | | | Rp 2.765.182.435,07 | Rp 2.765.182.435,07 | Rp 2.765.182.435,07 | Rp 2.765.182.435,07 | Rp 2.765.182.435,07 |
| Total Cash Out | | | | Rp 4.580.431.703,68 | Rp 4.580.431.703,68 | Rp 4.580.431.703,68 | Rp 4.580.431.703,68 | Rp 4.580.431.703,68 |
| Cash In | | | | | | | | |
| 1 | Cash In | IDR/year | | Rp 5.458.989.750,64 | Rp 5.458.989.750,64 | Rp 5.458.989.750,64 | Rp 5.458.989.750,64 | Rp 5.458.989.750,64 |
| 2 | Nilai Sisa | | | | | | | Rp 1.177.703.509,50 |
| Total *Cash In* | | | | Rp 5.458.989.750,64 | Rp 5.458.989.750,64 | Rp 5.458.989.750,64 | Rp 5.458.989.750,64 | Rp 6.636.693.260,14 |
| Interest Factor | | | | | | | | |
| 1 | (P/A) | | | 0,901 | 1,713 | 2,444 | 3,102 | 3,696 |
| 2 | (P/F) | | | | | | | 0,593 |
| Cash Flow Operation | | | - | Rp 791.493.823,07 | Rp 1.504.550.862,26 | Rp 2.146.945.477,74 | Rp 2.725.678.898,58 | Rp 3.247.060.050,11 |
| ***Net Present Value*** | | | **-Rp 7.350.000.000,00** | **-Rp 6.558.506.176,93** | **-Rp 5.053.955.314,67** | **-Rp 2.907.009.836,93** | **-Rp 181.330.938,35** | **Rp 4.243.432.621,26** |
| ***Profitability Index*** | | | | | | | | **0,58** |
| ***Payback Period*** | | | | | | | | **4,06** |

**Table 10.** *Cash Flow Fleet*

| CASHFLOW REPORT ON LOADING AND HAULING ACTIVITIES IN BLOCK 8 LIMESTONE MINING | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No | Information | | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
| Initial Cash Flow | | | | | | | | |
| Equipment Purchase Costs | | | | | | | | |
| 1 | UD Quester CWE 370 | 5 | Rp 4.875.000.000,00 | | | | | |
| 2 | Komatsu PC 400-8 Lc | 1 | Rp 1.500.000.000,00 | | | | | |
| Total Initial Cash Flow | | | Rp 6.375.000.000,00 | | | | | |
| Owning Cost | | | | | | | | |
| 1 | Depreciation | Rp/ton | | Rp 1.487.800.673,89 | Rp 1.487.800.673,89 | Rp 1.487.800.673,89 | Rp 1.487.800.673,89 | Rp 1.487.800.673,89 |
| 2 | Average Investment | Rp/ton | | Rp 98.194.844,48 | Rp 98.194.844,48 | Rp 98.194.844,48 | Rp 98.194.844,48 | Rp 98.194.844,48 |
| Total Owning Cost | | | | Rp 1.585.995.518,37 | Rp 1.585.995.518,37 | Rp 1.585.995.518,37 | Rp 1.585.995.518,37 | Rp 1.585.995.518,37 |
| Operational Cost | | | | | | | | |
| 1 | Oil Cost | Rp/ton | | Rp 219.322.542,06 | Rp 219.322.542,06 | Rp 219.322.542,06 | Rp 219.322.542,06 | Rp 219.322.542,06 |
| 2 | Maintanance Cost | Rp/ton | | Rp 1.487.800.673,89 | Rp 1.487.800.673,89 | Rp 1.487.800.673,89 | Rp 1.487.800.673,89 | Rp 1.487.800.673,89 |
| 3 | Employee Salary | Rp/ton | | Rp 827.147.810,59 | Rp 827.147.810,59 | Rp 827.147.810,59 | Rp 827.147.810,59 | Rp 827.147.810,59 |
| Total Operational Cost | | | | Rp 2.534.271.026,54 | Rp 2.534.271.026,54 | Rp 2.534.271.026,54 | Rp 2.534.271.026,54 | Rp 2.534.271.026,54 |
| Total *Cash Out* | | | | Rp 4.120.266.544,91 | Rp 4.120.266.544,91 | Rp 4.120.266.544,91 | Rp 4.120.266.544,91 | Rp 4.120.266.544,91 |
| Cash In | | | | | | | | |
| 1 | *Cash In* | Rp/year | | Rp 5.609.092.246,74 | Rp 5.609.092.246,74 | Rp 5.609.092.246,74 | Rp 5.609.092.246,74 | Rp 5.609.092.246,74 |
| 2 | Trade in Value | | | | | | | Rp 1.021.477.533,75 |
| Total Cash In | | | | Rp 5.609.092.246,74 | Rp 5.609.092.246,74 | Rp 5.609.092.246,74 | Rp 5.609.092.246,74 | Rp 6.630.569.780,49 |
| Interest Factor | | | | | | | | |
| 1 | (P/A) | | | 0,901 | 1,713 | 2,444 | 3,102 | 3,696 |
| 2 | (P/F) | | | | | | | 0,593 |
| Cash Flow Operation | | | - | Rp 1.341.284.563,60 | Rp 2.549.648.257,36 | Rp 3.638.265.699,93 | Rp 4.619.001.343,32 | Rp 5.502.546.444,89 |
| ***Net Present Value*** | | | **-Rp 6.375.000.000,00** | **-Rp 5.033.715.436,40** | **-Rp 2.484.067.179,04** | **Rp 1.154.198.520,89** | **Rp 5.773.199.864,21** | **Rp 12.297.223.842,85** |
| ***Profitability Index*** | | | | | | | | **1,93** |
| ***Payback Period*** | | | | | | | | **2,68** |

### 4.4 Sensitivity Analysis

*a. Fleet 1:6*

Sensitivity analysis was carried out regarding changes in prices, operational costs which increased and income decreased. From the calculations that have been carried out, when using 6 means of transport the NPV value can be said to be feasible when the increase in operational costs is a maximum of 10% with an NPV value of Rp. 965,175,562.69, whereas if income decreases by 10%, you will experience a loss of -Rp. 2,228. 462,851.43.

In the Payback period analysis, the same calculation is carried out, namely by increasing operational costs and decreasing income from the original assumptions. Based on the calculations that have been made, the 1:6 fleet cannot return the capital at the end of 5 years of equipment use. If a 10% operational cost sensitivity analysis is carried out, the PBP is obtained for 5.10 years, and if a 10% reduction in income is carried out, the PBP is obtained for 7.77 years.

Based on profitability index analysis, fleet 1:6 is considered unprofitable with a value of 0.58. A business is considered profitable if the PI value is greater than 1, therefore using 6 loading equipment is considered unprofitable over a period of 5 years of using the equipment.

**Table 11.** Sensitivity Analysis of NPV

| Sensitivity Analysis of NPV | | |
|---|---|---|
| Operational Cost | +10% | Rp 965.175.562,69 |
| | +5% | Rp 2.604.304.091,97 |
| | +0% | Rp 4.243.432.621,26 |
| Income | 0% | Rp 4.243.432.621,26 |
| | -5% | Rp 1.007.484.884,91 |
| | -10% | -Rp 2.228.462.851,43 |

**Table 12.** Sensitivity Analysis of PBP

| Sensitivity Analysis of PBP | | |
|---|---|---|
| Operational Cost | +10% | 5,10 |
| | +5% | 4,48 |
| | +0% | 4,06 |
| Income | 0% | 4,06 |
| | -5% | 5,08 |
| | -10% | 7,77 |

**Table 13.** Sensitivity Analysis of PI

| Sensitivity Analysis of PI | | |
|---|---|---|
| Operational Cost | +10% | 0,13 |
| | +5% | 0,35 |
| | +0% | 0,58 |
| Income | 0% | 0,58 |
| | -5% | 0,14 |
| | -10% | -0,30 |

*b. Fleet 1:5*

The NPV value obtained when using 1 dig-loading tool and 5 transport tools when operational costs are increased by 20% from the original costs, the company will get a profit of +Rp.6,288,222,935.19. Meanwhile, if revenue decreases by 20%, the company will experience a loss of -Rp. 1,002,474,590.65.

In the PBP analysis, when using 5 means of transportation by increasing operational costs by 20%, capital returns can be made in 3.46 years. Meanwhile, if you reduce income by 20%, the return on capital will take longer, namely 6.49 years.

In the PI analysis when increasing operational costs, the 1:5 fleet still experiences a profit if operational costs increase by 15% with a PI value of 1.22, whereas if revenue decreases by -5% the company still makes a profit with a PI value of 1.41%.

**Table 14.** Sensitivity Analysis of NPV

| Sensitivity Analysis of NPV | | |
|---|---|---|
| Operational Cost | +20% | Rp 6.288.222.935,19 |
| | +15% | Rp 7.790.473.162,10 |
| | +10% | Rp 9.292.723.389,02 |
| | +5% | Rp 10.794.973.615,93 |
| | +0% | Rp 12.297.223.842,85 |
| Income | 0% | Rp 12.297.223.842,85 |
| | -5% | Rp 8.972.299.234,47 |
| | -10% | Rp 5.647.374.626,10 |
| | -15% | Rp 2.322.450.017,72 |
| | -20% | -Rp 1.002.474.590,65 |

**Table 15.** Sensitivity Analysis of PBP

| Sensitivity Analysis of PBP | | |
|---|---|---|
| Operational Cost | +20% | 3,46 |
| | +15% | 3,22 |
| | +10% | 3,03 |
| | +5% | 2,88 |
| | +0% | 2,68 |
| Income | 0% | 2,68 |
| | -5% | 3,07 |
| | -10% | 3,58 |
| | -15% | 4,46 |
| | -20% | 6,49 |

**Table 16.** Sensitivity Analysis of PI

| Sensitivity Analysis of PI | | |
|---|---|---|
| Operational Cost | 20% | 0,99 |
| | 15% | 1,22 |
| | 10% | 1,46 |
| | 5% | 1,69 |
| | 0% | 1,93 |
| Income | 0% | 1,93 |
| | -5% | 1,41 |
| | -10% | 0,89 |
| | -15% | 0,36 |
| | -20% | -0,16 |

## 5. Conclusion

a. If you use 1 dig-loading tool and 6 transport tools for mining activities in block 8, you get a match factor value of 1.275, whereas if you use 1 dig-load tool and 5 transport tools you get a match factor value of 1.0
b. From the analysis that has been carried out, if you use 1 digging and loading equipment and 6 transportation tools, the production that can be done in one day is 2,834,702 tons, whereas if you use 5 transportation tools, the production that can be produced in one day is 2,912,646 tons. tons.
c. The total cost of ownership and operational costs if using 1 digging - loading tool and 6 transport tools per year is IDR 4,623,043,230.95. Meanwhile, if you use 1 digging and loading equipment and 5 transportation equipment, the total annual ownership and operational costs that must be incurred are IDR 4,290,157,392.02.
d. After carrying out investment analysis and sensitivity analysis of operational costs and income. So it can be assessed that the use of 1 dig-loading tool and 5 transport tools is more profitable in terms of production, and the income generated than the use of 1 dig-loading tool and 6 transport tools.

## 6. Suggestion

a. Conditions when collecting cycle time data in October may be different from conditions in other months, therefore it is necessary to evaluate production and match factor analysis every month in order to get maximum benefits from the mining activities that have been carried out.
b. This research can be used as a reference for fleet use in block 8 in the following months.

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