



OPTIMIZATION OF STONE GRINDING PRODUCTS WITH FUZZY MULTY-OBJECTIVE LINEAR PROGRAMMING (FMOLP) APPROACH AT CV. ABC

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ABSTRACT

Mining is an industry or company that processes natural resources, where the production process is carried out in various ways, both manually and with material processing machines. The results of the production supply produced by the company always meet the needs (Demand) needed in each region. From the results of observations, there is an opportunity to be able to produce more and more profitable production capacity so that it is necessary to optimize the production results that have been recorded using the Fuzzy Multi-Objective Linear Programming approach method processed with LINGO software. So that there is hope that the results of the data processing will produce maximum values, limit values or target values from a production process that have met the requirements according to the supply and demand data from the mining. Namely, 72 tons of Urug Sand, 80 tons of fine sand, 64 tons of gravel.



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1. Introduction

The abundance of natural resources is caused by Indonesia being the country with the second highest biodiversity level after Brazil. With this fact, it shows the high diversity of natural resources owned by this country. Indonesia's abundant wealth is formed by several factors including: first, from an astronomical perspective, Indonesia is located in a tropical area that has high rainfall, so that the land becomes fertile and overgrown with trees. Second, from a geological perspective, Indonesia is located at the point of tectonic plate movement so that many mountains are formed that are rich in minerals. Third, the waters in Indonesia are rich in food sources for various types of plants and marine animals, and contain various types of mineral sources. (Supriyadi, 2015). In today's mining industry where the mining business is experiencing challenges, especially with government policies on export restrictions and products that are required to have added value and the market price of products that have decreased recently, mining companies must be able to increase competitiveness with strategies to

increase productivity and efficiency, reduce costs, increase the use of new technology and make continuous improvements *in* their production processes.

Table 1. Production Supply of CV. ABC

No	Product name	Types of products (Ton)/Day	Location Marketing	Transportation
1	Sand landfill	72	Bangil , Rembang , Sukorejo, Jabon , Beji	Pick Up Truck
2	Sand Fine	80		
3	Rock Gravel	64		
AMOUNT		216		

Source : Internal Company

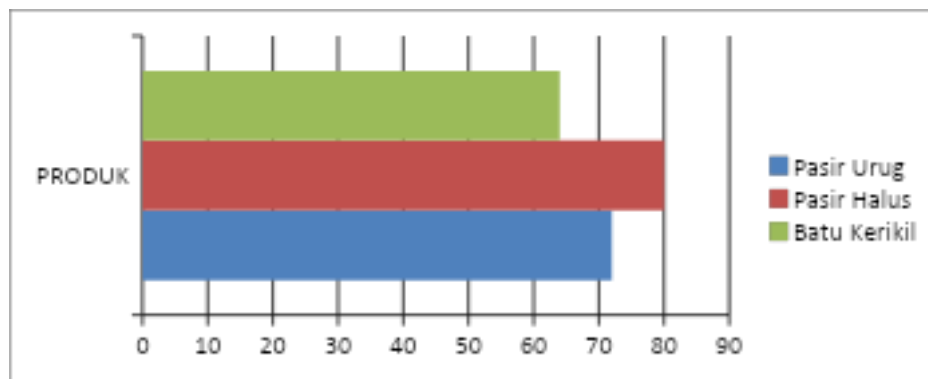


Figure 1. Production Supply Diagram

The stone and sand mining industry, for example, can make the human environment change, change and shift from one situation to another. In general, we see that in various regions there has been environmental damage as a result of human behavior with the use of modern technology, forcing the environment to be unable to survive in its original form and function (Nurmilawaty, 2015).

The tight competition in small and medium enterprises (SMEs) that produce similar products will make these SMEs motivated to create more interesting and diverse innovations and be selective in the quality of the products produced, and in general the main purpose of establishing a business is to obtain sufficient and maximum profit from the business operations carried out. However, in reality, a business often experiences many obstacles or problems that hinder it in achieving its business goals. The problem faced by businesses in general is how to optimize the products that must be produced in order to obtain maximum profit.

CV. ABC is one of the companies engaged in the mining of sand and stone materials located in Gunung Sari Village, Beji District, Pasuruan Regency. This company has been operating since the 1990s producing mining materials from mountains and supplying them to various regions, especially East Java. This company is capable of producing hundreds of tons of materials every day to meet the needs of consumers who want to buy materials at CV. ABC.

Marketing and grinding of materials carried out by CV. ABC refers to sales data carried out per day which refers to each truck that comes to buy stone material products sold by CV. ABC, namely

first, sand fill with a production volume of 72 tons per day, fine sand 80 tons per day, gravel 64 tons per day with a total of all materials of 216 tons equal to 27 dump trucks.

2. Review Literature

According to the Great Dictionary of the Indonesian Language, optimization comes from the basic word optimal which means the best, the highest, the most profitable, making the best. making the highest, optimizing the process, the way, the act of optimizing (making the best, the highest, and so on) so that optimization is an action, process, or methodology to make something (as a design, system, or decision) more/completely perfect, functional, or more effective. The benefits of optimization include:

1. Can minimize Cost .
2. Look for profit maximum .
3. Maximize results production .
4. Prevent excessive waste .
5. Seek and find out every constraint in production process .

Mining is basically an effort to utilize natural resources in the form of minerals contained in and on the surface of the earth. Not only digging and taking resources, after that a mining company will preserve the nature that has been mined in order to maintain the balance of its natural ecosystem. The benefits of mining are:

1. Utilise source Power existing nature .
2. Give field Work for inhabitant native .
3. Make it easy public enjoy results nature .
4. Can help state finances if the results are exported .
5. Help the country's economy .

Linear programming method is the right method to solve problems experienced by the company. *Linear programming method* helps companies by combining existing product variations based on the limited resources owned by the company. Thus the company can produce optimally to obtain maximum profit.

3. Methodology

Based on the observation results, several company data have been found, namely the results of supply, marketing and transportation equipment, the amount of production produced is the same as the amount of demand whose marketing is carried out in several areas around Pasuruan Regency, to calculate and find solutions, the solution that will be used is the linear programming approach, namely finding values or solutions from several data found. The research flow diagram is a chart *that* shows the flow *in* a program or system procedure logically. *Flowcharts* are used as communication tools and for documentation, *flowcharts* usually make it easier to solve a problem, especially problems that need to be studied and evaluated further.

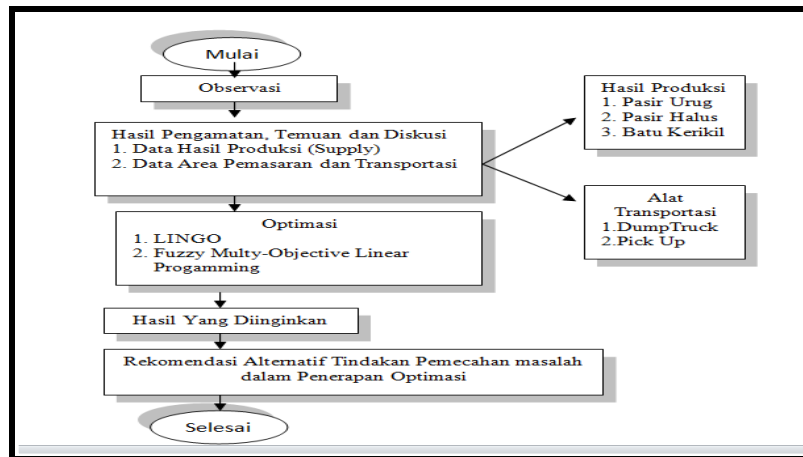


Figure 2. Research Flow Diagram

Identification process through understanding of references from several journals on optimization of stone mining related to the production process at CV. ABC after that completed with a concept or method that is in accordance with the identification of the problem. In addition to journals, the author also seeks references from theses and previous studies to support this research so that it can be well-structured and clarify this literature study.

4. Results and Discussion

The data compiled for this final assignment is data in the form of demand, inventory, marketing places to marketing costs. The data is designed according to the needs of writing the final assignment which at the time of conducting research observations was accompanied by a supervisor from CV. ABC. The results will be input in carrying out optimization calculations using the *Fuzzy Multi-Objective Linear Programming method*. Details of activities in the *Single Objective Linear Programming model* are as follows:

Table 2. Types of Production Results

No	Name Product	Type Product (Ton)	Location Marketing	Transportation
1	Sand landfill	72	Bangil , Rembang , sukorejo,jabon , Beji	Truck Pick Up
2	Sand Fine	80		
3	Rock Gravel	64		

Table 3. Marketing Area Needs

No	Location	Demand (Ton)
1	Bangil	40
2	Sukorejo	48
3	Soap	40
4	Rembang	32
5	Beji	56
Total		216

Marketing and grinding of materials carried out by CV. ABC refers to sales data carried out per day which refers to each truck that comes to buy stone material products sold by CV. ABC, namely

first, sand fill with a production volume of 72 tons per day, fine sand 80 tons per day, gravel 64 tons per day with a total of all materials of 216 tons equal to 27 dump trucks.

Objective Function Formula:

$$\text{Min } Z = \sum_{j=1}^5 \sum_{i=1}^3 c_{ij} x_{ij} + \sum_{k=1}^2 \sum_{j=1}^5 c_{jk} x_{jk}$$

Where:

- Z = Total Cost
- c_{ij} = Cost transportation product from origin (i) to area marketing (j)
- c_{jk} = Cost distribution product from area marketing (j) with use tool transportation (k)
- x_{ij} = Total products transported (i) to area marketing (j)
- x_{jk} = Total products distributed to area marketing (j) with use tool transportation (k).

The number of each product (i) of each type of product produced (j).

$$\sum_{j=1}^5 X_{ij=S_1}$$

with $j = \{1,2,3...5\}$

Where :

- j = 1 □ District Bangil
- j = 2 □ District Sukorejo
- j = 3 □ Jabon District
- j = 4 □ District Rembang
- j = 5 □ Beji District .

The number of products sent from the marketing area (j) using transportation (k) => the number of products (i) sent to the marketing area (j)

$$\sum_{k=1}^2 X_{jk} \geq \sum_{i=1}^3 X_{ij}$$

Number of deliveries to marketing areas (j) using means of transportation (k) = number of product requirements using means of transportation (k)

$$\sum_{k=1}^5 X_{jk} = dx$$

with $k = \{1,2\}$

Where :

- k = 1 → Truck
- k = 2 → Pick Up

Completion

Lingo Model

sets :

```

number_supply / 1.. 3 /:supply ;
marketing_area / 1.. 5 /:demand ;
transportation_tools / 1.. 2 /: capacity ;
marketing_supply( supply_amount, marketing_area ):supply_ij , cost_ij ;
shipping_demand( marketing_area, transportation_tool ):shipping_jk , cost_jk ;
end sets
    
```

```

data :
supply=
72, 80, 64;
demand=
40, 48, 40, 32, 56;
capacity =
200000, 100000;
cost_ij =
50000, 55000, 40000,
50000, 55000, 40000,
50000, 55000, 40000,
50000, 55000, 40000,
50000, 55000, 40000;
    
```

```

cost_jk =
150000, 200000, 200000, 150000, 200000,
50000, 75000, 100000, 50000, 100000;
end data
    
```

```

min = @sum (marketing_supply( i,j ):cost _ij( i,j )*supply_ij( i,j))+ @sum (demand_shipping( j,k
):cost _jk( j,k )*jk_shipping( j,k ));
    
```

! amount of supply;

```
@for (supply_sum(i) : @ sum (marketing_supply( i,j):(supply_ij( i,j) ))= supply(i));
```

! amount sent ;

```
@for (marketing_area(j) : @sum ( marketing_supply( i,j):supply _ij( i,j))< = @sum
(demand_shipping( j,k):shipping _jk( j,k )))
```

!request marketing ;

```
@for (marketing_area(j) : @ sum (marketing_supply( i,j):(supply_ij( i,j) ))= demand(j));
```

! capacity count ;

```
@for (transportation_tool(k) : @sum ( demand_shipping( j,k):(jk_shipping( j,k) ))= capacity(k));
```

The data above is the data that is entered to In the lingo model set, the data is obtained from data taken in the company with compare mark mark constraints which are then input into in the software ling shingga produce data as above

Generated Model Report

MODEL :

```

[_1] MIN = 150000 * SHIPPING_JK_1_1 + 200000 * SHIPPING_JK_1_2 + 200000
* SHIPPING_JK_2_1 + 150000 * SHIPPING_JK_2_2 + 200000 *
SHIPPING_JK_3_1 + 50000 * SHIPPING_JK_3_2 + 75000 *
SHIPPING_JK_4_1 + 100000 * SHIPPING_JK_4_2 + 50000 *
SHIPPING_JK_5_1 + 100000 + 15000 * SUPPLY_IJ_1_1 +
25000 * SUPPLY_IJ_1_2 + 20000 * SUPPLY_IJ_1_3 + 15000 *
SUPPLY_IJ_2_1 + 25000 * SUPPLY_IJ_2_2 + 20000 * SUPPLY_IJ_2_3 + 15000
SUPPLY_IJ_3_1 + 25000 * SUPPLY_IJ_3_2 + 20000 *
    
```

SUPPLY_IJ_3_3;
 [_2] SUPPLY_IJ_1_1 + SUPPLY_IJ_1_2 + SUPPLY_IJ_1_3 + SUPPLY_IJ_1_4 +
 SUPPLY_IJ_1_5 <= 72 ;
 [_3] SUPPLY_IJ_2_1 + SUPPLY_IJ_2_2 + SUPPLY_IJ_2_3 + SUPPLY_IJ_2_4 +
 SUPPLY_IJ_2_5 <= 80 ;
 [_4] SUPPLY_IJ_3_1 + SUPPLY_IJ_3_2 + SUPPLY_IJ_3_3 + SUPPLY_IJ_3_4 +
 SUPPLY_IJ_3_5 <= 64 ;
 [_23] - PENGIRIMAN_JK_1_1 - PENGIRIMAN_JK_1_2 + SUPPLY_IJ_1_1 +
 SUPPLY_IJ_2_1 + SUPPLY_IJ_3_1 >= 0 ;
 [_24] - PENGIRIMAN_JK_2_1 - PENGIRIMAN_JK_2_2 + SUPPLY_IJ_1_2 +
 SUPPLY_IJ_2_2 + SUPPLY_IJ_3_2 >= 0 ;
 [_25] - PENGIRIMAN_JK_3_1 - PENGIRIMAN_JK_3_2 + SUPPLY_IJ_1_3 +
 SUPPLY_IJ_2_3 + SUPPLY_IJ_3_3 >= 0 ;
 [_26] - PENGIRIMAN_JK_4_1 - PENGIRIMAN_JK_4_2 + SUPPLY_IJ_1_4 +
 SUPPLY_IJ_2_4 + SUPPLY_IJ_3_4 >= 0 ;
 [_27] - PENGIRIMAN_JK_5_1 - PENGIRIMAN_JK_5_2 + SUPPLY_IJ_1_5 +
 SUPPLY_IJ_2_5 + SUPPLY_IJ_3_5 >= 0 ;
 [_33] SUPPLY_IJ_1_1 + SUPPLY_IJ_2_1 + SUPPLY_IJ_3_1 <= 40 ;
 [_34] SUPPLY_IJ_1_2 + SUPPLY_IJ_2_2 + SUPPLY_IJ_3_2 <= 48 ;
 [_35] SUPPLY_IJ_1_3 + SUPPLY_IJ_2_3 + SUPPLY_IJ_3_3 <= 40 ;
 [_36] SUPPLY_IJ_1_4 + SUPPLY_IJ_2_4 + SUPPLY_IJ_3_3 <= 32 ;
 [_37] SUPPLY_IJ_1_5 + SUPPLY_IJ_2_5 + SUPPLY_IJ_3_5 <= 56 ;
 [_43] SHIPMENT_JK_1_1 + SHIPMENT_JK_2_1 + SHIPMENT_JK_3_1 +
 SHIPPING_JK_4_1 + SHIPPING_JK_5_1 = 200000 ;
 [_44] SHIPMENT_JK_1_2 + SHIPMENT_JK_2_2 + SHIPMENT_JK_3_2 +
 SHIPPING_JK_4_2 + SHIPPING_JK_5_2 = 100000 ;

END

Variable Value Reduced Cost

SUPPLY(1)	72.00000	0.000000
SUPPLY(2)	80.00000	0.000000
SUPPLY(3)	64.00000	0.000000
DEMAND(1)	40.00000	0.000000
DEMAND(2)	48.00000	0.000000
DEMAND(3)	40.00000	0.000000
DEMAND(4)	32.00000	0.000000
DEMAND(5)	56.00000	0.000000
KAPASITAS(1)	200000.0	0.000000
KAPASITAS(2)	100000.0	0.000000
SUPPLY_IJ(1, 1)	0.000000	5000.000
SUPPLY_IJ(1, 2)	0.000000	0.000000
SUPPLY_IJ(1, 3)	40.00000	0.000000
SUPPLY_IJ(1, 4)	0.000000	5000.000
SUPPLY_IJ(1, 5)	32.00000	0.000000
SUPPLY_IJ(2, 1)	40.00000	0.000000
SUPPLY_IJ(2, 2)	0.000000	0.000000
SUPPLY_IJ(2, 3)	0.000000	20000.00
SUPPLY_IJ(2, 4)	32.00000	0.000000
SUPPLY_IJ(2, 5)	8.000000	0.000000
SUPPLY_IJ(3, 1)	0.000000	25000.00
SUPPLY_IJ(3, 2)	48.00000	0.000000
SUPPLY_IJ(3, 3)	0.000000	25000.00
SUPPLY_IJ(3, 4)	0.000000	25000.00
SUPPLY_IJ(3, 5)	16.00000	0.000000
COST_IJ(1, 1)	50000.00	0.000000

COST_IJ(1, 2)	55000.00	0.000000
COST_IJ(1, 3)	40000.00	0.000000
COST_IJ(1, 4)	50000.00	0.000000
COST_IJ(1, 5)	55000.00	0.000000
COST_IJ(2, 1)	40000.00	0.000000
COST_IJ(2, 2)	50000.00	0.000000
COST_IJ(2, 3)	55000.00	0.000000
COST_IJ(2, 4)	40000.00	0.000000
COST_IJ(2, 5)	50000.00	0.000000
COST_IJ(3, 1)	55000.00	0.000000
COST_IJ(3, 2)	40000.00	0.000000
COST_IJ(3, 3)	50000.00	0.000000
COST_IJ(3, 4)	55000.00	0.000000
COST_IJ(3, 5)	40000.00	0.000000
PENGIRIMAN_JK(1, 1)	40.00000	0.000000
PENGIRIMAN_JK(1, 2)	0.000000	50000.00
SHIPPING_ JK(2 , 1)	0.000000	50000.00
SHIPPING_ JK(2 , 2)	48.00000	0.000000
SHIPPING_ JK(3 , 1)	0.000000	150000.0
SHIPPING_ JK(3 , 2)	99952.00	0.000000
SHIPPING_ JK(4 , 1)	32.00000	0.000000
SHIPPING_ JK(4 , 2)	0.000000	25000.00
SHIPPING_ JK(5 , 1)	199928.0	0.000000
PENGIRIMAN_JK(5, 2)	0.000000	50000.00
COST_JK(1, 1)	150000.0	0.000000
COST_JK(1, 2)	200000.0	0.000000
COST_JK(2, 1)	200000.0	0.000000
COST_JK(2, 2)	150000.0	0.000000
COST_JK(3, 1)	200000.0	0.000000
COST_JK(3, 2)	50000.00	0.000000
COST_JK(4, 1)	75000.00	0.000000
COST_JK(4, 2)	100000.0	0.000000
COST_JK(5, 1)	50000.00	0.000000
COST_JK(5, 2)	100000.0	0.000000

Row	Slack or Surplus	Dual Price
1	0.1501880E+11	-1.000000
2	0.000000	-155000.0
3	0.000000	-150000.0
4	0.000000	-140000.0
5	0.000000	100000.0
6	0.000000	100000.0
7	99912.00	0.000000
8	0.000000	25000.00
9	199872.0	0.000000
10	0.000000	10000.00
11	0.000000	0.000000
12	0.000000	115000.0
13	0.000000	85000.00
14	0.000000	100000.0
15	0.000000	-50000.00
16	0.000000	-50000.00

This process will be done by verifying comparing the results produced by the model with company data. Which is summarized in a table complete with mathematical formulas and the amount

of production data from calculations using the *Fuzzy Multy-Objective Linear Programming method* so that it is easy to see the results of the calculations.

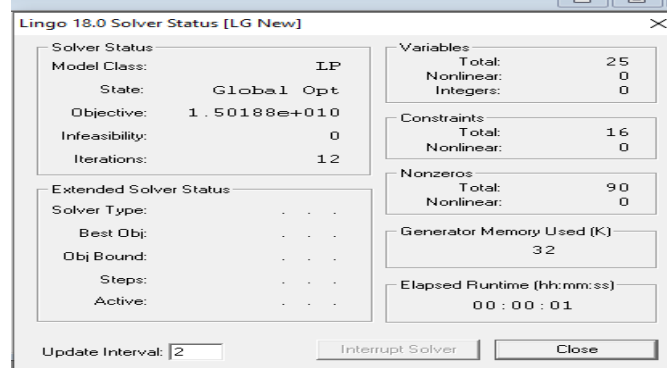
Table 4. Request Limit Data

REQUEST LIMITATION					
No	$\sum_{j=1}^5 x_{ij} = S_1$		Company Data	Location	Status
1	16+16+8= 40	=	40	Bangil	Fulfilled
2	8+32+16=56	=	56	Sukorejo	Fulfilled
3	8+16+16=40	=	40	Soap	Fulfilled
4	16+8+8=32	=	32	Rembang	Fulfilled
5	24+8+16=48	=	48	Beji	Fulfilled

Inventory Limit Data Capacity

CAPACITY SUPPLIES LIMITATIONS					
No	$i = 13 X_{ij} \geq b_j$		Inventory Data	Product	Status
1	16+8+8+16+24 = 72	=	72	Pasir Urugu	Terpenhu
2	16+32+16+8+8 = 80	=	80	Pasir Desire	Terpenhu
3	8+16+16+8+16 = 64	=	64	Pebble Stone	Terpenhu

Indicator	Hasil
State	Global Optimal
Objective Value	1.50188e+010
Infeasibility	0
Total Solver Iterations	12
Runtime Second	0
Model Class	LP
Total Variables	25
Nonlinear variable	0
Integer Variabel	0
Total Constraints	16
Nonlinear Constraints	0
Total nonzeros	90
Nonlinear nonzeros	0



Gambar 3. Lingo Model System
Source : Data Processing Results

In this process, verification is carried out on the model that has been produced in the previous process. Verification is used to ensure the truth of the model that has been produced according to or violates the limits. Verification is carried out by comparing the output produced from the model and the original data from CV. Alam Kaya's material mining results. To find out, the output results are substituted into the limits so that it can be seen that all limits have been met.

From the discussion and results above, it states that the final assignment or thesis can be completed with lingo software supported by laptop type hardware with *AMD A4 QUAD CORE processor*, 2 GB RAM, 500 GB hard disk. And supported by the Windows 8 operating system as the operating system, Ms. Word as a typing medium and Lingo Software as a data processing medium to be optimized. From the data above, it explains that the status is a global optimum which means it can be solved with an optimal solution, with an objective value of $1.50188e + 010$ with a runtime time of 0.01. Due to the absence of nonlinear variables and nonlinear constraints, the problem above can be solved with a linear programming approach. The data is also feasible or error-free with the discovery of *infeasibility* or impossible results of 0. After the data is processed with a mathematical formula, the results of the supply and demand data are met.

5. Conclusion

Based on the processes and methods that have been compiled in the previous chapters, several conclusions can be drawn, including:

1. Formulation data results stone grinding produced more detailed and detailed, so in the future can be made as base or production process reference stone grinding at CV. Alam Kaya.
2. The process of model optimization and verification is carried out with Enter production supply and production demand data use Fuzzy Multi -Objective Linear Programming method supported by LINGO software becomes more detailed and clear.

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