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OPTIMIZATION ANALYSIS OF PRODUCTION COSTS AND PROFITS OF SPICY NOODLE VARIANTS OF MIE RATU SITUBONDO UMKM USING THE BRANCH AND BOUND METHOD

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ABSTRACT

This study aims to optimize production planning at UMKM Mie Ratu Situbondo, particularly for two main products, namely Mie Ratu Galak and Mie Ratu Ganas, in order to maximize daily profit and reduce inefficiencies in the use of raw materials. The background of this research is the production decision-making process that is still based on estimation, which often leads to suboptimal results and potential waste. The research method used is linear programming with the Simplex method, followed by the Branch and Bound method to obtain integer solutions. Data were collected through observation and interviews with the business owner over a period of more than seven days and were aggregated into daily average values. The analysis was carried out using MATLAB software. The results show that the optimal production combination is 63 portions of Mie Ratu Galak and 67 portions of Mie Ratu Ganas per day, resulting in a maximum profit of Rp1,434,000 per day. Compared to the previous condition, this result indicates an increase in profit and a more efficient allocation of resources. This study provides practical benefits for UMKM actors by offering a systematic and quantitative approach to production planning, which can support better managerial decision-making and improve business performance.

Keywords : Branch and Bound Method, MATLAB Software, Profit Optimization, Production Cost.

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PRELIMINARY

Production optimization is one of the important issues in the field of operational management, especially in the context of micro, small and medium enterprises (MSMEs), because it is directly related to the efficiency of resource use and increasing profits (Ismail et al., 2022). Various studies have examined production optimization problems using a linear programming approach with the Simplex method and its development method.

Several studies have shown that the Simplex method is effective for determining optimal production combinations. (Angesti et al., 2024) This study applied the Simplex method with the help of the POM-QM application to optimize production profits in a bakery business, resulting in production quantity recommendations that can significantly increase profits. This study proves that linear programming can be used as a decision-making tool in production planning.

Furthermore, (Sahrir, 2025) used the Branch and Bound method to determine the optimal product combination in an industry, thus obtaining a solution in the form of a more realistic integer for application in production practice. The results of this study indicate that the Branch and Bound method is able to complement the Simplex method by producing an optimal solution that is appropriate to real-world conditions.

Another study by (Hasanah et al., 2024) applied the Branch and Bound method to the problem of determining the optimal combination of locally processed foods for stunting management. This study demonstrated that the Branch and Bound method is effective in solving optimization problems with certain constraints and is capable of providing applicable integer solutions. Meanwhile, (Winursito et al., 2023) emphasized that a linear programming-based optimization approach can improve the efficiency of production resource utilization, both in terms of raw materials, labor, and operational costs.

Although various studies have successfully applied the Simplex and Branch and Bound methods to solve optimization problems, most studies still focus on the manufacturing sector, large-scale industries, or case studies outside the context of regional culinary MSMEs. Furthermore, some studies only use the Simplex method without considering more realistic integer solutions for production decision-making.

Based on this research gap, this study focuses on optimizing production profits in culinary MSMEs, specifically Mie Ratu Situbondo MSMEs, by applying the Simplex method with MATLAB software and then using the Branch and Bound method to obtain integer solutions. The novelty of this research lies in the integrated application of the Simplex and Branch and Bound methods to a noodle-based culinary MSME in the Situbondo region, resulting in production quantity recommendations that are not only mathematically optimal but also realistic and directly applicable to production decision-making at the MSME level.

METHODS

This research was conducted at the Mie Ratu Situbondo UMKM, focusing on the best-selling noodle menus: Mie Ratu Galak and Mie Ratu Ganas. This quantitative research, using a case study approach, aimed to determine the optimal production volume to maximize profits. The steps taken in analyzing the data in this study are as follows:

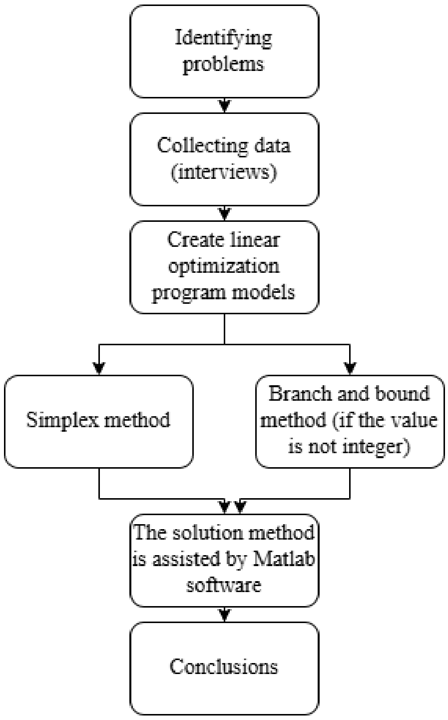

Figure 1. Research method analysis process

1. Data Collection Methods

a. Field Study

The field study was conducted through direct observation and interviews with the owner of the Mie Ratu Situbondo MSME, which began on January 4, 2026, and lasted for more than seven days of operation. The data collected included the most popular menu items, daily production volume, raw material requirements, raw material prices, and the profit earned from each menu item sold. The collected daily data was then aggregated into a daily average to be used as the basis for optimization modeling.

b. Literature Review

The author sought references related to previously existing optimization problems, particularly those using the Simplex and Branch and Bound methods, to gain a deeper understanding of the application of these methods to efficient production management.

2. Data Analysis Method

a. Optimization Modeling Using Linear Programming

The modeling of the production profit optimization problem in this study was conducted using Linear Programming. Optimization is an effort to obtain the best results from an activity or process in an effective and efficient manner (Rizal et al., 2024). Production cost optimization can be defined as the process of planning and controlling all cost components involved in production activities with the goal of achieving minimum costs without compromising the quality or quantity of the product produced (Nurfatwa et al., 2024).

According to (Hidayah et al., 2025), linear programming is a mathematical method for solving optimization problems by maximizing or minimizing an objective function subject to linear constraints. In general, the steps in linear programming include determining decision variables, formulating the objective function, formulating constraints, and determining non-negativity constraints.

The determination of decision variables is carried out to represent the quantities whose values will be determined in the optimization process (Sugianto & Susanti, 2021). The formulation of an objective function aims to obtain maximum or minimum results in accordance with the desired objectives (Yuspira & Fitrianti, 2024). Constraints are formulated to represent resource limitations encountered in the production process, ensuring that the resulting solution remains within realistic limits (Alam et al., 2021). The non-negativity constraint indicates that the decision variable value cannot be negative.

The mathematical model in this study is formulated as follows.

For example:

x_1 = Quantity of Mie Ratu Galak production

x_2 = uantity of Mie Ratu Ganas production

Objective function:

Maximize Z= $P_1x + P_2y$

With constraints

$a_1x + a_2y \leq b_1$

$a_3x + a_4y \leq b_2$

$x, y \geq 0$

b. Simplex Method

The Simplex Method is a linear programming method that works systematically and algorithmically to obtain optimal solutions (Gultom et al., 2025)(Palahudin et al., 2025). This method is widely used to solve various real-life optimization problems, such as maximizing profits or minimizing costs (Ghasani et al., 2025)(Sulistiawati et al., 2025)(Ambarsari et al., 2024).

According to (Ria Agustina et al., 2024) and (Jamal & Sari, 2022), the Simplex method relies on numerical calculations through an iterative process until an optimal solution is obtained. This method was chosen because it can efficiently solve optimization problems with multiple constraints.

c. Branch and Bound Method

The Branch and Bound method is an optimization method used to obtain optimal solutions to linear programming problems, requiring decision variables to be integers (Revika et al., 2025)(Firdaus et al., 2025) and (Guo & Vanhoucke, 2025). This method is used as a follow-up to the Simplex method when the optimal solution obtained is still a fractional number, requiring further optimization to obtain a more realistic solution that can be implemented in production practice (Ouhadi et al., 2025).

According to (Purba & Ginting, 2025), the Branch and Bound process is carried out by selecting decision variables with fractional values for branching, then forming two new subproblems with upper and lower bounds. Each subproblem is evaluated based on the bound value, eliminating branches that do not have the potential to produce better solutions. This process is terminated when all decision variables meet the integer requirement and no branches can produce a more optimal solution.

d. MATLAB Software

All calculations were performed using MATLAB software to solve the linear programming model using the Simplex method, while the Branch and Bound method was used to obtain the optimal integer solution.

RESULT AND DISCUSSION

Based on observations and interviews, it was discovered that the Mie Ratu Situbondo MSME had been determining production volumes based on daily demand estimates without structured mathematical calculations. The production pattern applied was still based on intuition, resulting in frequent imbalances between production volumes and demand. This situation has the potential to lead to wasted raw materials and suboptimal profits. Therefore, a production optimization analysis is necessary to determine the combination of production volumes that maximizes profits.

The optimization modeling in this study was conducted using two decision variables, namely the production volume of Mie Ratu Galak (x) and the production volume of Mie Ratu Ganas (y). The objective function used is to maximize profits, namely:

$$Z=10.000x+12.000y$$

The constraints in the availability of key raw materials such as wheat flour, eggs, water, chilies, flavorings, soy sauce, cooking oil, LPG, and other supporting materials, as shown in Table 1.

Table 1. Data on Raw Material Availability and Production Requirements for Making "Mie Ratu"

No	Constraint	x	y	Availability
1.	Wheat flour	0,076 kg	0,076 kg	10 kg
2.	Eggs	0,015 kg	0,015 kg	2 kg
3.	Water	0,076 liters	0,076 liters	10 liters
4.	Chili peppers	0,015 kg	0,015 kg	2 kg
5.	Seasoning	0,015 kg	0,015 kg	2 kg
6.	Spices	0,076 kg	0,076 kg	10 kg
7.	Soy sauce	0,015 liters	0,023 liters	2,5 liters
8.	Cooking oil	0,015 liters	0,015 liters	2 liters
9.	LPG gas cylinders	0,046 kg	0,046 kg	6 kg
10.	Styrofoam	0,015 pcs	0,015 pcs	130 pcs
11.	Chicken	0,015 kg	0,015 kg	2 kg
12.	Sausage patty	0,015 pack	0,015 pack	2 pack
13.	Chopsticks	0,015 pack	0,015 pack	2 pack

A. Mathematical modeling of linear programming using the simplex method

1) Variables used

x= Mie ratu galak
y= Mie ratu ganas

2) Objective Function

Z=10.000x+12.000y

3) Constraints

a) Wheat Flour Inventory = $0{,}076x + 0{,}076y \leq 10$

b) Egg Inventory = $0{,}015x + 0{,}015y \leq 2$

c) Water Inventory = $0{,}076x + 0{,}076y \leq 10$

d) Chili Inventory = $0{,}015x + 0{,}015y \leq 2$

e) Seasoning Inventory = $0{,}015x + 0{,}015y \leq 2$

f) Spice Inventory = $0{,}076x + 0{,}076y \leq 10$

g) Soy Sauce Inventory = $0{,}015x + 0{,}023y \leq 2{,}5$

h) Cooking Oil Inventory = $0{,}015x + 0{,}015y \leq 2$

i) LPG Inventory = $0{,}046x + 0{,}046y \leq 6$

j) Styrofoam Inventory = $0{,}015x + 0{,}015y \leq 130$

k) Chicken Inventory = $0{,}015x + 0{,}015y \leq 2$

l) Sausage Patty Inventory = $0{,}015x + 0{,}015y \leq 2$

m) Chopstick Inventory = $0{,}015x + 0{,}015y \leq 2$

4) Standard form of the function Objective

Z=10.000x+12.000y+0.a+0.b+0.c+0.d+0.e+0.f+0.g+0.h+0.i+0.j+0.k+0.l+0.m

5) Basic form of the constraint function

$0{,}076x + 0{,}076y + a \leq 10$
$0{,}015x + 0{,}015y + b \leq 2$
$0{,}076x + 0{,}076y + c \leq 10$
$0{,}015x + 0{,}015y + d \leq 2$
$0{,}015x + 0{,}015y + e \leq 2$
$0{,}076x + 0{,}076y + f \leq 10$
$0{,}015x + 0{,}023y + g \leq 2{,}5$
$0{,}015x + 0{,}015y + h \leq 2$
$0{,}046x + 0{,}046y + i \leq 6$
$0{,}015x + 0{,}015y + j \leq 130$
$0{,}015x + 0{,}015y + k \leq 2$
$0{,}015x + 0{,}015y + l \leq 2$
$0{,}015x + 0{,}015y + m \leq 2$

6) **Non-negativity constraints**
$x, y \geq 0$

7) **Simplex Method**

Based on the mathematical model formulated through linear programming above, here are the steps to solve the optimization model using MATLAB software with the linprog function :

1. Write the objective function: Max then f=[-10000 -12000];
2. rite the constraint matrix A (constraint) and vector b (constraint constraint):
A=[0.076 0.076;0.015 0.015;0.076 0.076;0.015 0.015;0.015 0.015;0.076 0.076;0.015 0.023;0.015 0.015;0.046 0.046;0.015 0.015;0.015 0.015;0.015 0.015;0.015 0.015];
b=[10 2 10 2 2 10 2.5 2 6 130 2 2 2];
3. rite the constraint equations : Aeq=[ ]; and beq=[ ];
4. rite the decision variable boundaries: Since, $x, y \geq 0$ then,
lb=[0 0 0 0 0 0 0 0 0 0 0 0 0]; and ub=[ ];
5. Write the linprog function: : [X,Z]=linprog(f,A,b,Aeq,beq,lb,ub).
6. isplay the optimization results in MATLAB software

8) **Simplex Method Results**

Based on calculations using the Simplex method with the aid of MATLAB software, the optimal solution was obtained as x=62.5 and y=67, with a maximum profit of Rp1,440,217 per day. These results demonstrate that mathematically, this production combination is capable of generating maximum profits by efficiently utilizing available resources.

However, because the results are fractional, this solution is not realistic for everyday production, considering that production quantities must be expressed in whole numbers. Therefore, a more advanced method is needed to obtain a more realistic and applicable solution.

```
Command Window
>> f=[-10000 -12000];
>> A=[0.076 0.076;0.015 0.015;0.076 0.076;0.015 0.015;0.015 0.015;0.076 0.076;0.015 0.023;0.015 0.015;0.046 0.046;0.015 0.015;0.015 0.015;0.015 0.015;0.015 0.015];
>> b=[10;2;10;2;2;10;2.5;2;6;130;2;2;2];
>> Aeq=[];
>> beq=[];
>> lb=[0 0 0 0 0 0 0 0 0 0 0 0 0];
>> ub=[];
>> [X,Z]=linprog(f,A,b,Aeq,beq,lb,ub)
Warning: Length of lower bounds is > length(x); ignoring extra bounds.
> In checkbounds (line 73)
In linprog (line 270)

Optimal solution found.


X =

     125/2
    3125/46


Z =

-1440217

>> format rat
>> Z=Z*-1

Z =

 1440217
```

Figure 2. Testing the simplex method using Matlab software

9) Branch and Bound Method Results

The Branch and Bound method uses a Branch and Bound method to obtain an integer solution. Based on the Branch and Bound tree diagram shown in the figure, in Iteration 1, an integer solution was obtained that satisfied all constraints: x = 63 and y = 67. With the objective function f = 10,000x + 12,000y, the maximum profit is f = 10,000(63) + 12,000(67) = 630,000 + 804,000 = 1,434,000.

These results indicate that the optimal production volume to achieve maximum profit is 63 portions per day for Mie Ratu Galak and 67 portions per day for Mie Ratu Ganas, with a maximum profit of IDR 1,434,000 per day. This solution was chosen because it provided the highest profit among the other integer solutions while still meeting all raw material availability constraints. Therefore, the obtained solution is realistic and applicable to daily production activities.

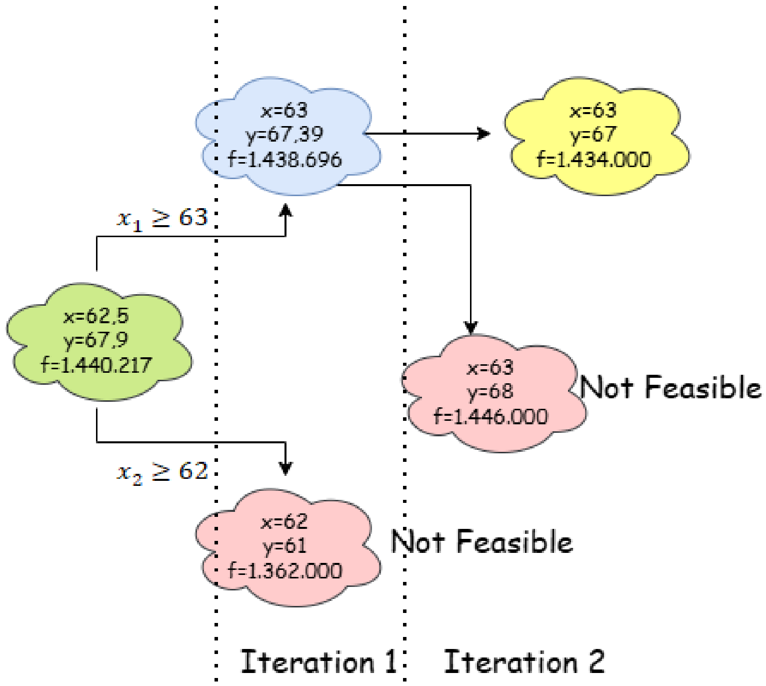

Figure 3. results of branch and bound method calculations using Matlab software

Compared to the pre-optimization period, the maximum profit earned by the Mie Ratu Situbondo MSME was Rp1,410,000 per day. However, after optimization using the Simplex and Branch and Bound methods, profits increased to Rp1,434,000 per day, representing a daily profit increase of Rp24,000, or approximately 1.7%. These results indicate that applying the optimization method can help determine more precise production volumes for Mie Ratu Galak and Mie Ratu Ganas, allowing for more controlled raw material use and reducing potential waste. Several key raw materials, such as wheat flour, eggs, and soy sauce, are limiting factors in the optimization process, so their availability significantly impacts optimal production volumes.

Practically, these results can serve as a reference for MSME owners in planning daily production volumes more efficiently and measurably. These findings also align with research by (Angesti et al., 2024) and (Hasanah et al., 2024), which found that the Simplex and Branch and Bound methods are effective in determining optimal production combinations and increasing business profits.

CONCLUSION

The production optimization problem faced by the Mie Ratu Situbondo MSME, specifically in determining the production volume of Mie Ratu Galak and Mie Ratu Ganas, can be analyzed using a linear programming approach with the Simplex method followed by the Branch and Bound method. The optimization results indicate that the combined production of 63 portions of Mie Ratu Galak and 67 portions of Mie Ratu Ganas per day yields a maximum profit of Rp1,434,000 per day, which is higher than the pre-optimization condition. These findings suggest that the optimization model can assist MSMEs in more structured production planning, controlling raw material usage, and reducing potential waste in the production process.

However, this study still has limitations, including the use of linearity assumptions in the modeling, static data, and the failure to consider demand uncertainty and raw material price fluctuations. Therefore, the optimization results obtained are still approximate and subject to change if conditions change in the field. For future research, it is recommended that the model be developed to incorporate dynamic demand, more detailed operational costs, and comparison with other optimization methods. The use of software such as MATLAB can be used as an aid in the calculation process, but its effectiveness still depends on the quality of the data and the accuracy of the modeling used.

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