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OPTIMIZATION OF LABOR ALLOCATION TO MAXIMIZE CRACKER PRODUCTION DURING RAMADAN USING A LINEAR PROGRAM

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ABSTRACT

The increase in demand for crackers during the Ramadan period requires optimal labor management to keep production efficient. This research aims to determine the optimal number of workers to maximize cracker production. The method used is linear programming with a simplex approach, with data obtained through interviews and processed using MATLAB. The model is formulated with a decision variable in the form of the number of workers at each stage of the production process. The purpose function is formulated to maximize total production by considering capacity constraints, operational time, and labor costs. The results of the study show that the optimal solution is obtained in $x_1 = 2, x_2 = 1, x_3 = 1$. The maximum value of the objective function obtained is 80kg/day of production or equivalent to a 300% increase in cost efficiency per kg of Rp333.33. The allocation shows the most efficient distribution of labor in meeting resource limitations. Further research is recommended to consider dynamic demand factors and variations in production capacity.

Keywords: Optimization, Workforce, Linear Program

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PRELIMINARY

During Ramadan demand, the surge in demand for crackers encourages the need for optimal workforce management in MSMEs (Pharisees, 2022). Misuse of worker allocation has the potential to cause production inefficiencies, operational cost overruns, and failure to achieve production targets (Nugraha et al., 2022). Therefore, determining the optimal number of workers in each production process is crucial in strategic decision-making (Tarigan & Aria Aji Priyanto, 2021).

The method used to optimize labor allocation is a linear program, a linear program is one of the mathematical optimization methods used to determine the best solution to a problem with a linear function of goals and constraints (Alam et al., 2021). The linear program used is the simplex method (Brevik et al., 2020). In workforce planning, decision variables must be integer to reflect the reality that workers cannot be recruited fractionally

(Irysad et al., 2024). However, linear programming methods often result in fractional solutions (Ambarsari & Fadia, 2025). Nonetheless, in certain cases the optimal solution is direct in the form of integers, allowing direct implementation without additional complex optimization methods (Fadillah et al., 2024).

Linear programs have been widely used in various studies to optimize production in MSMEs, especially in maximizing profits and determining the optimal production combination as done by Aizah et al., (2023). The study proved effective in optimizing the production volume of snacks such as banana chips and fried noodles (Nurhidayah et al., 2023). However, special studies on integer labor optimization in food MSMEs are still very limited because workers cannot be recruited fractionally. Therefore, this study aims to overcome this gap through labor optimization modeling based on rill production conditions, to produce optimal worker allocation that maximizes cracker production.

METHODS

This study uses an applied mathematical modeling approach to determine the optimal number of workers in the production process (Gita Dwikasari et al., 2024). This approach is used to model real problems into mathematical forms so that mathematically optimal solutions are obtained (Siswanto & Meiliasari, 2024).

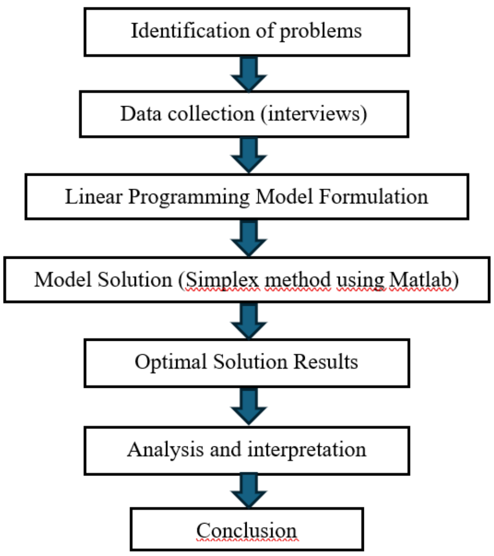

Image 1. Research Flow Diagram

1. Data Collection

The data was obtained through a single structured interview with Mrs. Sherly, the owner of MSMEs producing crackers in Situbondo, on November 10, 2025. This interview resulted in the following model parameters that became the basis for the formulation of mathematical programming (Muhammad Irvan Ardianto et al., 2025):

Table 1. Parameters of the Cracker MSME Production Optimization Model

Remarks	Production	Cutting	Drying	Availability
Number of Requests	20kg	20kg	20kg	600kg
Operating Hours	3 hours	2.5 hours	2.5 hours	180 hours
Employee Salary	20.000	20.000	20.000	80,000/day

2. Linear Program Modeling

   The decision variables in this study are stated:

   x_1 = Number of production process workers

   x_2 = Number of workers cutting process

   x_3 = Number of drying process workers

   With the function of the purpose :

   $\max Z = 20x_1 + 20x_2 + 20x_3$
   Constraints:
   $20x_1 + 20x_2 + 20x_3 \leq 600$
   $3x_1 + 2{,}5x_2 + 2{,}5x_3 \leq 180$
   $20.000x_1 + 20.000x_2 + 20.000x_3 \leq 80.000$
   $x_1, x_2 +, x_3 \geq 1$

3. Data Analysis Methods

   The data analysis method used for optimization is linear programming with a simplex method approach to determine the optimal solution to the problem of optimizing the number of workers (Pratama et al., 2024). This method was chosen because it was able to solve the problem of optimizing the number of workers (Mentari, 2018). Model completion is carried out to obtain a combination of decision variables that meet all constraints and provide optimal results with the help of MATLAB software to improve accuracy and calculation efficiency (Ambarsari et al., 2024).

RESULT AND DISCUSSION

Based on the results of the interview with Mrs. Sherly, it is known that production demand increases during the month of Ramadan. This requires optimal labor management so that the production process remains efficient, so that the data obtained is used as a basis for the preparation of optimization models (Maerani et al., 2024).

The data obtained includes information related to the production process, operational time, and labor costs. Furthermore, the data is presented in the form of an availability table as a basis for the preparation of the optimization model (Susanti, 2021).

Table 2. Constraint Coefficient and Resource Availability

Yes	Constraint	x_1	x_2	x_3	Availability
1.	Production (kg)	20	20	20	600
2.	Time (hours)	3	2,5	2,5	180
3.	Cost (Rp)	20.000	20.000	20.000	80,000/day

1. Formulation of Linear Program Models Using the Simplex Method

   The formulation of the linear program model is compiled based on the data availability of data sources used in the production process

   1) Decision Variables

      x_1 = Number of production workers

      x_2 = Total Cutting Workforce

      x_3 = Total drying workforce

   2) Purpose Function

      $Z = 20_{x1} + 20_{x2} + 20_{x3}$

   3) Contrains

      $20_{x1} + 20_{x2} + 20_{x3} \leq 600$

      $3_{x1} + 2{,}5_{x2} + 2{,}5_{x3} \leq 180$

      $20.000_{x1} + 20.000_{x2} + 20.000_{x3} \leq 80.000$

   4) Standard Form or Objective Function

      $Z = 20_{x1} + 20_{x2} + 20_{x3} + 0.a + 0.b + 0.c$

   5) Standard Form of Constraints

      $20_{x1} + 20_{x2} + 20_{x3} + a \leq 600$

      $3_{x1} + 2{,}5_{x2} + 2{,}5_{x3} + b \leq 180$

      $20.000_{x1} + 20.000_{x2} + 20.000_{x3} + c \leq 80.000$

   6) Non-negativity constraints

      $x_1, x_2, x_3 \geq 1$

2. Implementation of the Simplex Method with Matlab

   Model completion is carried out using matlab with a linprog function.

1) Vector function destination is defined as $f = [-20 - 20 - 20]$
2) Constraint matrix $A = \begin{bmatrix} 20 & 20 & 20; \\ 3 & 2.5 & 2.5; \\ 20000 & 20000 & 20000 \end{bmatrix}$
3) Constraint boundary vector $b = [600 \quad 180 \quad 80000]$
4) Equation constraints $Aeq = [\,]$, $beq = [\,]$
5) Variable limit, lower limit upper limit $lb = [1\ 1\ 1]ub = [\,]$
6) Optimal solution is obtained by running

   $[X, Z] = linprog(f, A, b, Aeq, beq, lb, ub)$,
7) The value of the destination function is multiplied by -1 to return the form of the minimization to the maximation $(Z^* - 1)$

3. Simplex Method Calculation Results with Matlab

   Based on the results of the calculation of the simplex method using matlab, an optimal solution was obtained by

   $x_1 = 2$ (Production Workers)

   $x_2 = 1$ (cutting section workers)

   $x_3 = 1$ (Drying Section Worker)

   $Z = 80$ (Total Production)

```
Command Window
>> f=[-20 -20 -20];
>> A=[20 20 20;3 2.5 2.5;20000 20000 20000];
>> b=[600;180;80000];
>> Aeq=[];
>> beq=[];
>> lb=[1 1 1];
>> ub=[];
>> [X,Z]=linprog(f,A,b,Aeq,beq,lb,ub)

Optimal solution found.


X =

     2
     1
     1


Z =

   -80
```

Image 2. Optimization Troubleshooting Results Using MATLAB Software

The addition of one worker to the production process has been proven to increase capacity to 80kg/day. Quantitatively, the addition of one worker in the production process increases capacity from 20kg/day to 80kg/day, or equivalent to a 300% increase. An additional cost of Rp20,000/day for extra workers resulted in a cost efficiency per kg of

Rp333.33, showing that proper labor allocation can maximize output without exceeding budget (Concern, 2025). This result has practical implications for MSMEs, namely that management can add workers to the production department when demand is high to meet output targets without exceeding budget. However, this study is limited to data from a single interview as well as constant productivity and budget assumptions, so the variability of real conditions is not fully reflected.

Sensitivity analysis confirms that changes in budget or capacity per worker will affect the optimal solution, for example, a 25% increase in labor costs can reduce the optimal number of workers, while a surge in demand of up to 100kg/day requires additional workers in all parts. This shows that optimal solutions are dynamic, but the model still provides practical and quantitative guidance for decision-making in periods of high production (Rumetna et al., 2021).

CONCLUSION

Based on the completion of the model using the simplex method with the help of MATLAB software, the optimal number of manpower obtained is four people, namely $x_1 = 2, x_2 = 1, x_3 = 1$. The addition of one worker to the production process has been proven to increase capacity from 20kg/day to 80kg/day, or equivalent to a 300% increase in cost efficiency per kg of Rp333.33. These results show that systematically planning the number of workers can increase the efficiency of food MSME production, especially during peak periods such as Ramadan. With this model, management can make more informed operational decisions, optimize human resources and increase output without incurring cost wastage.

However, this study has limitations. The data used comes from only one interview, and the model assumes worker productivity as well as a fixed salary budget. For further research, it is recommended to expand the scope of data by involving several MSMEs, considering the variability of productivity per worker, adding other operational factors. This will make the model more applicative, realistic, and able to provide more accurate managerial recommendations for MSMEs in the food sector.

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