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Optimizing Production for Maximum Profit in Kripik Ma'Nung MSMEs Using CPLEX-Based Linear Programming

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Abstract

Micro, Small, and Medium Enterprises (MSMEs) significantly contribute to the economic development of Indonesia. However, many MSMEs still rely on intuition and past experience rather than data-driven decision-making, resulting in suboptimal profit outcomes. This study aims to determine the optimal production combination to maximize profit in Kripik Ma'Nung, a halal-certified MSME that produces five types of traditional chips. A linear programming approach was applied using CPLEX Optimization Studio 22.1.2 to analyze real production data, including unit cost, production time, and selling price. The decision variables were the weekly production quantities of each chip type, subject to constraints on production cost and time.
The initial production plan yielded a weekly profit of IDR 370,200 with a production time of 1,478.8 minutes. After optimization, the model suggested producing only 166 units of sale banana chips, which increased the profit to IDR 448,200, reduced production time to 1,377.8 minutes, and cut costs by IDR 78,000. These results demonstrate a 21% improvement in profit efficiency and highlight the effectiveness of linear programming as a decision-support tool. The study encourages broader adoption of optimization techniques among MSMEs to enhance resource utilization and operational decision-making.

Keywords : Optimization, CPLEX, UMKM, Chips.

INTRODUCTION

In Indonesia, over 66 million MSMEs operate across diverse sectors, making them a vital pillar of the nation's economy. There are more than 66 million MSMEs operating across Indonesia, highlighting their significant contribution to the national economy. This shows how big their role is in the national economy. MSMEs contribute significantly to job creation.

However, not all MSMEs understand how much a product should be produced to achieve maximum profit. Most MSMEs rely on previous experience. As a result, optimal production methods have not been implemented. This MSME, located in Bumiayu, Brebes, is engaged in producing snacks such as banana chips, cassava chips, sale banana chips, and manggleng.

One of the quantitative approaches that can be used to help decision making in this problem is linear programming. The use of this method in this study aims to determine the optimal combination of production quantities by considering constraints in the form of production costs, production time and production capacity. By implementing linear programming, Ma' Nung Chips UMKM business actors can make more rational and measurable decisions.

The objective of this study is to optimize the production strategy of the Ma'Nung Chips MSME by determining the most profitable product mix using linear programming implemented via the CPLEX software.

METHODS

Linear Programming

Linear programming is a mathematical technique used to determine the optimal outcome, such as maximizing profits or minimizing costs, within a system constrained by linear relationships. It is frequently applied in operational planning, including resource allocation and production scheduling (Di Wu, 2020). Thelinear programming method is an appropriate approach to solving problems faced by companies. This method helps companies by combining various product alternatives based on the limitations of the available resources. In this way, companies can carry out production optimally to achieve maximum profit (Sugiarto, 2013).

Linear programming refers to a quantitative method for identifying optimal outcomes under a defined set of constraints represented linearly (Budiasih, 2013). According to S. Hillier and Lieberman (2012), the standard form of linear programming is:

The objective function is: Maximize $Z = c_1x_1 + c_2x_2 +$
$... + c_nx_n$ subject to the following constraints :
$a_{11}x_1 + a_{12}x_2 + ... +$
$a_{1n}x_n \geq b_1$ $a_{21}x_1 + a_{22}x_2$
$+ ... + a_{2n}x_n \geq b_2$ $a_{m1}x_1$
$+ a_{m2}x_2 + ... + a_{mn}x_n \geq$
b_m and $x_1 \geq 0$, $x_2 \geq 0$,
..., $x_n \geq 0$, then:
Z = denotes the objective function to be maximized.
xj = the level of activity j (for j = 1, 2, ..., n)
cj = the increase in the value of Z resulting from a one-unit increase in activity level xj
bi = available resource i available (for i =
1, 2, ..., m) ai = available resource i used
per unit of activity j
n = The quantity of operations depending on the given resource constraints
m = the number of resource or facility constraints

CPLEX Application

IBM ILOG CPLEX Optimization Studio is a comprehensive software platform for solving complex optimization problems. It supports linear, integer, and mixed-integer programming, offering accuracy, flexibility, and strong performance—particularly beneficial in academic and industrial applications.

Flowchart

Flowchart of the Research

The research process begins with a real case occurring at the Kripik Ma'Nung MSME located in Brebes, Central Java, and continues through to the final stage of solution and discussion. The complete flow can be seen in Figure 1. Research Flow below:

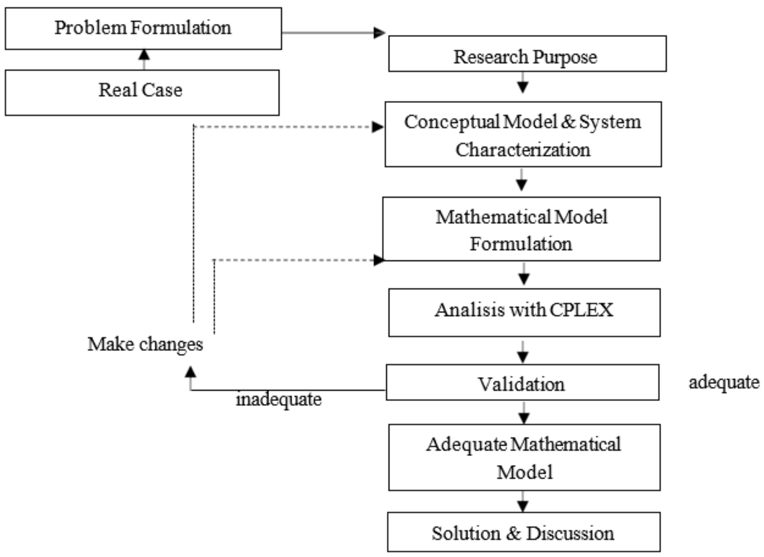

Figure 1. Flowchart of the Research

CONSEPTUAL MODEL

This model describes the relationship between each variable, constraint function and objective function. The conceptual model can be seen in Figure 2. The following Conceptual Model:

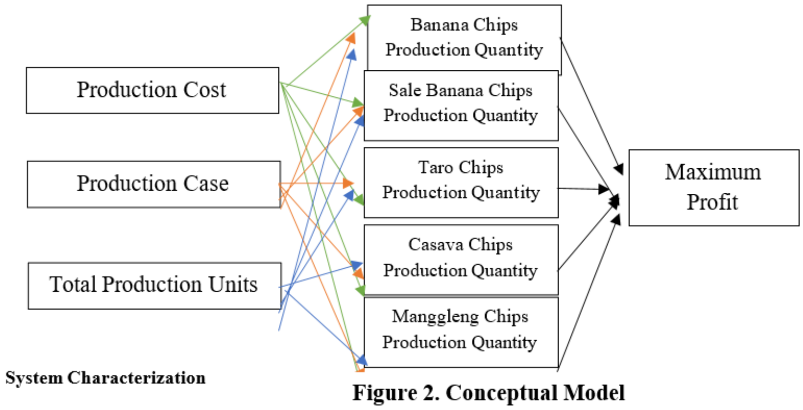

Figure 2. Conceptual Model

The problem in this case study is constrained by several assumptions, including the following:
1. Parameter values such as production costs are assumed to be known with certainty, without considering price fluctuations.
2. The production process is assumed to run normally without any disruptions.
3. All finished goods are assumed to be sold in the market.

Object

This study focuses on the following items:
1. Banana Chips
2. Sale Banana Chips
3. Taro Chips
4. Cassava Chips
5. Manggleng Chips

Decision Variables

X_1 = Quantity of Banana Chips to be produced X_2 = Quantity of Cassava Chips to be produced
X_3 = Quantity of Sale Banana Chips to be produced X_4 = Quantity of Taro Chips to be produced
X_5 = Quantity of Manggleng Chips to be produced

Parameter or Constraint

Total Production Units: $a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + a_{14}x_4 + a_{14}x_4 \geq b_1$ (a_{ij} = 1, for each i and j)
Total Production Cost : $a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + a_{24}x_4 + a_{25}x_5 \geq b_2$
Total Time : $a_{31}x_1 + a_{32}x_2 + a_{33}x_3 + a_{34}x_5 + a_{35}x_5 \geq b_3$

Tujuan

Maximizing weekly profits at MSMEs of Keripik Ma' Nung. Profit Function: $Z = c_1x_1 + c_2x_2 + c_3x_3 + c_4x_4 + c_5x_5$

DATA SET

This study collected data by conducting direct interviews with the owner of the Kripik Ma'Nung UMKM in May 2025. The following is a Table 1. Observation Result Data of observation data:

Table 1. Observation Result Data

Result Data Observation	X1	X2	X3	X4	X5	Total
	Banana Chips	**Sale Banana Chips**	**Taro Chips**	**Casava Chips**	**Manggleng Chips**	
Production Quantity	30	36	30	40	30	166
Cost Production/Unit	8600	7300	8100	7300	7800	-
Selling Price/Unit	10000	10000	10000	10000	10000	-
Time Production/Unit	8	8.3	10	7	12	-
Profit/Unit	1400	2700	1900	2700	2200	-
Total Cost	258000	262800	243000	292000	234000	1289800
Total Time	240	298.8	300	280	360	1478.8
Total Selling	300000	360000	300000	400000	300000	1660000
Total Profit	42000	97200	57000	108000	66000	370200

MATHEMATICAL MODEL FORMULATION

Though Table 1. Observation Result Data, it is known that in each

1. Objective Function
   The variable X1, X2, X3, X4, and X5 obtained will maximize the profit function. $Z = 1400\ X_1 + 2700\ X_2 + 1900\ X_3 + 2700\ X_4 + 2200\ X_5$
2. Contraint
   Function Determine X_1, X_2, and X_3 with constraints:
   Total Production Units : $30\ X1 + 36\ X2 + 30\ X3 + 40\ X4 + 30\ X5 \leq 166$
   Total Cost : $8600\ X_1 + 7300\ X_2 + 8100\ X_3 + 7300\ X_4 + 7800\ X_5 \leq 1289800$
   Total Time : $8\ X_1 + 8.3\ X_2 + 10\ X_3 + 7\ X_4 + 12\ X_5 \leq 1473.8$
   Since the minimum production quantity for each chip type is one unit, the constraints should ensure that: $X_1, X_2, X_3, X_4, X_5 \geq 0$

ANALYSIS WITH CPLEX

The solution to optimize the profit of Ma'Nung chips using the IBM ILOG CPLEX Optimization Studio Community Edition 22.1.2 application by entering the objective function and constraint function into the syntax as shown in Figure 3. The following Mathematical Modeling Syntax:

```
maksimasikeuntungan.mod
/*********************************************
 * OPL 22.1.2.0 Model
 * Author: Asus
 * Creation Date: Jun 18, 2025 at 8:51:51 AM
 *********************************************/
dvar int X1; // decision variable kripik pisang // X1
dvar int X2; // decision variable kripik sale pisang // X2
dvar int X3; // decision variable kripik talas // X3
dvar int X4; // decision variable kripik singkong // X4
dvar int X5; // decision variable kripik manggleng // X5

//objective function//
maximize 1400*X1 + 2700*X2 + 1900*X3 + 2700*X4 + 2200*X5;

//contrains//
subject to {
X1 + X2 + X3 + X4 + X5 <=166;
8600*X1 + 7300*X2 + 8100*X3 + 7300*X4 + 7800*X5 <=1289800;
8*X1 + 8.3*X2 + 10*X3 + 7*X4 + 12*X5 <=1473.8;
X1>=0;
X2>=0;
X3>=0;
X4>=0;
X5>=0;
}

```

Figure 3. Syntax Pemodelan Matematis

After that, running is carried out with the steps as in Figure 4. Running steps below:

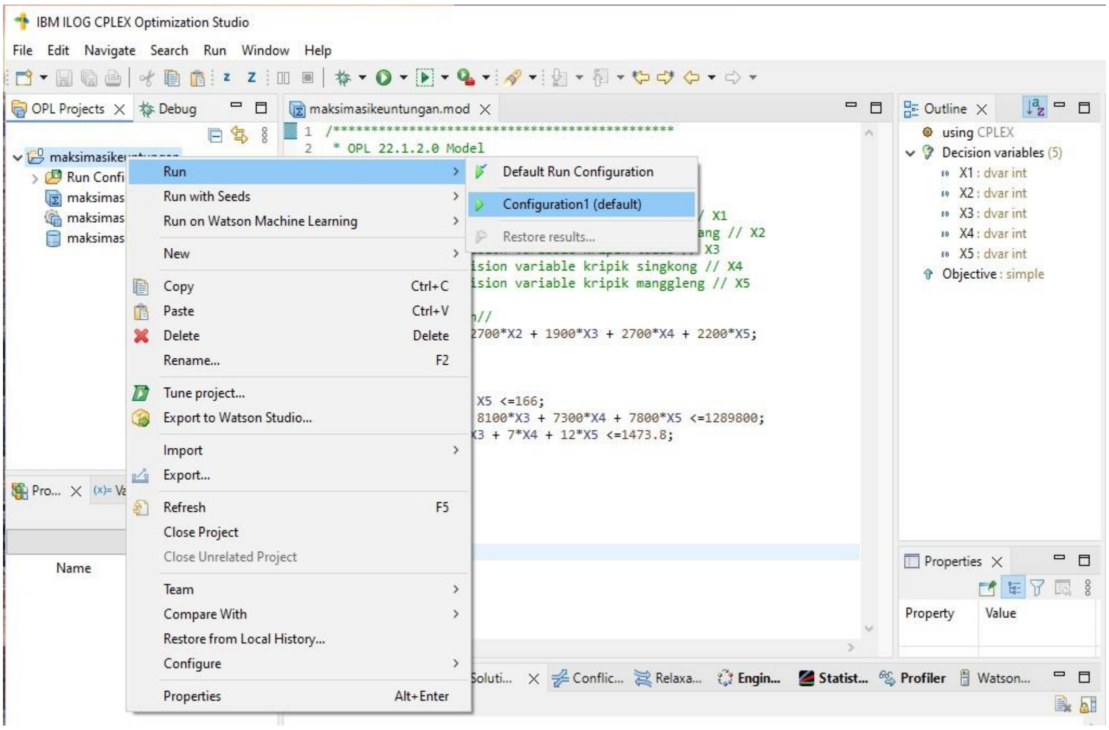

Figure 4. How to Run

Then the display after running with the CPLEX application can be seen in figure 5. Display After Running. While the display of the solution results of running the CPLEX application can be seen in figure 6. Solution from the CPLEX Application. Both images are below:

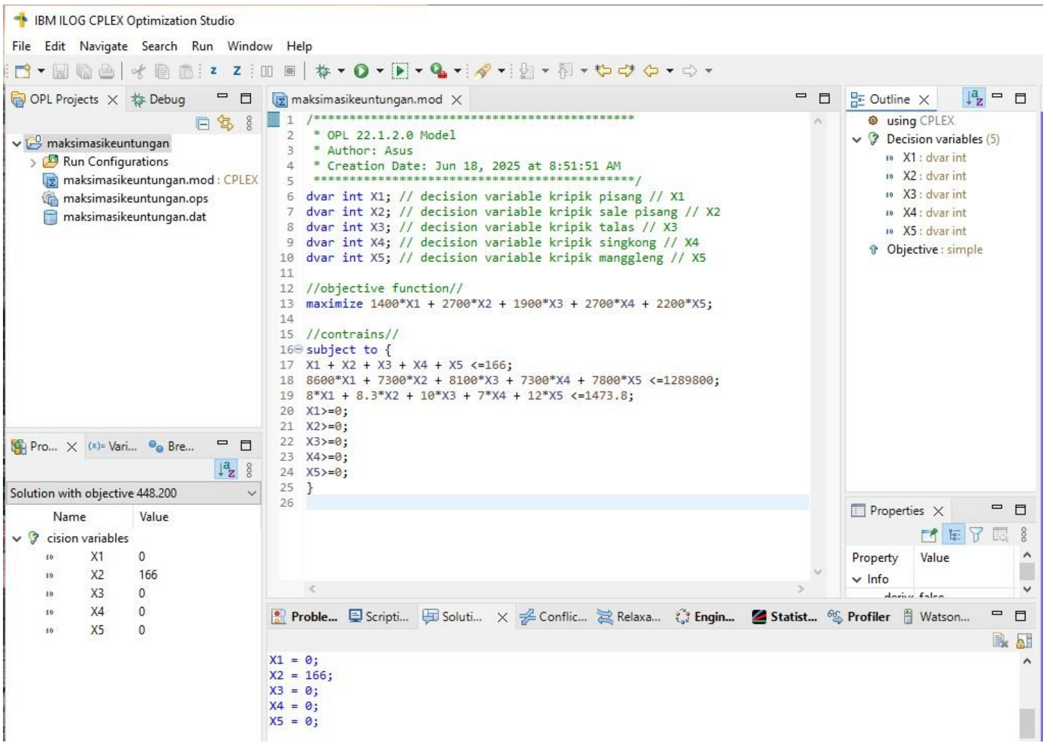

Figure 5. View After Running

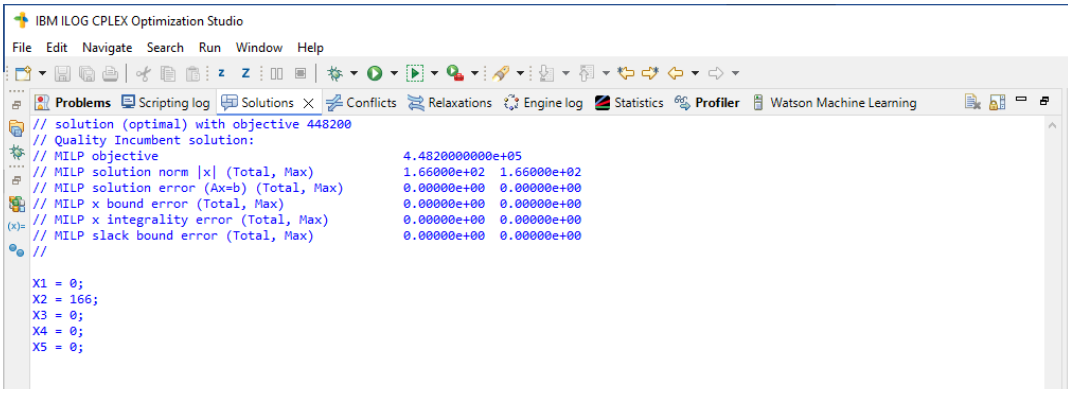

Figure 6. Solution of CPLEX Application

Figure 6 shows that the optimal solution to maximize profits at UMKM Kripik Ma'Nung. Then to see the efficiency of this case can be seen in table 2. The following research results efficiency:

Table 2. Research Result Efficiency

	Initial Condition	Final Condition	Efisiensi
Production	30 bananas chips 36 sale banan chips 40 taro chips 30 casava chips 30 manggleng chips	0 bananas chips 166 sale banan chips 0 taro chips 0 casava chips 0 manggleng chips	Production involves only a single product type
Production Cost	Rp 1.289.800,-	Rp 1.211.800,-	Rp 78.000,-
Time	1478.8 menit	1377.8 menit	101 menit
Profit	Rp 370.200,-	Rp 448.200,-	Rp 78.000,-

MATHEMATICAL VALIDATION MODEL

After processing the data using IBM ILOG CPLEX, the resulting values for each decision variable were as follows: X1 = 0, X2 = 166, X3 = 0, X4 = 0, and X5 = 0. Based on these results, the validity of the solution can be tested by verifying the mathematical model against the following constraints:

Total Production Units Constraint: : $X_1 + X_2 + X_3 + X_4 + X_5 \leq 166$

By substituting the values: $0 + 166 + 0 + 0 + 0 \leq 166$. The result is $166 \leq 166$. This satisfies the constraint, thus the result is valid.

Total Production Cost Constraint: $8600\ X_1 + 7300\ X_2 + 8100\ X_3 + 7300\ X_4 + 7800\ X_5 \leq 1289800$. Substituting the values: $8600*0 + 7300*166 + 8100*0 + 7300*0 + 7800*0 \leq 1289800$. The result is $1211800 \leq 1289800$. This satisfies the constraint, thus the result is valid.

Total Production Time Constraint : $8\ X_1 + 8.3\ X_2 + 10\ X_3 + 7\ X_4 + 12\ X_5 \leq 1473.8$. Substituting the values: $8*0 + 8.3*166 + 10*0 + 7*0 + 12*0 \leq 1473.8$. The result is $1377.8 \leq 1473.8$. This means that the value meets the requirements. So it can be declared valid.

CONCLUSION

Initially, the Kripik Ma'Nung MSME produced five types of chips per week: banana chips, sale banana chips, taro chips, cassava chips, and manggleng chips. The weekly production consisted of 30 units of banana chips, 36 units of sale banana chips, 30 units of taro chips, 40 units of cassava chips, and 30 units of manggleng chips.

The total capital spent to produce these chips amounted to IDR 1,289,800, with a production time of 1,478.8 minutes, resulting in a profit of IDR 370,200.

After being analyzed using the IBM ILOG CPLEX Optimization Studio Community Edition 22.1.2 application, adjustments to the production quantities were required in order to achieve maximum profit. The adjustment involved producing 166 units of sale banana chips while ceasing the production of the other four types of chips. As a result, cost efficiency of IDR 78,000 was achieved, with a reduced production time of 101 minutes and a profit of IDR 78,000. Resulting in an efficiency percentage of 21%.

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