Profit Optimization Using Simplex Methods on Home Industry Bintang Bakery in Sukarame Bandar Lampung

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Abstract. The home industry of Bintang Bakery in producing three types of bread had not received the maximum profit yet. Raw material purchasing that was doing still use estimating methods. Based on these conditions, this research will provide a production picture to maximize the profits on the home industry of Bintang Bakery. The purpose of this research is to optimize the benefits of the Bintang Bakery home industry. Profit optimization calculations performed used Lindo tools. The results of calculations by using the simplex method and Lindo aids show that the production results applied by the Bintang Bakery home industry are optimal. The optimal profit level of Rp 19,750,000 by producing 3740 flavored pieces of bread, 1300 packaged bread rolls and 520 loaves of bread packaging Star Bakery industry experienced a profit increase of Rp 250,000 by using the simplex method.

1. Introduction
Today's business competition is getting tighter and harder, with more and more companies growing. This condition causes many companies to want to be at the forefront of their fields. So that for every company must be able to develop and improve performance to achieve effectiveness and efficiency [1].

Production activities are the chain of consumption and distribution. Activity is a process that produces goods and services, then is consumed by consumers. To produce goods and services production activities involve many factors of production. The production function describes the relationship between the number of inputs and output that can be produced within a certain period of time [2]. The development of the industrial world that is currently developing will create high competition. So that it will affect the profits of each company. New ideas are needed to bring the business world into a more advanced direction so that it can keep up with the increasingly tight competition. The broader the knowledge a person has, the higher the level of thinking [3].

At present many independent businesses have sprung up, such as home industries. Home industry is a product business house or a small company. Home industry is also called the home industry because it is included in the category of small businesses that are managed by the family [4].

The common problem faced by large, medium and small companies is how to combine factors of production or resources that are owned jointly so as to obtain maximum profits at a minimum cost. Problems related to the process of maximizing profits on star Bakery home industry is the process of finding optimal solutions in production. There is a linear relationship of the level of profit, factors of production and products produced by the company, to solve the optimization problem is used linear programming analysis tool (linear program) using the simplex method [5].

The simplex method is the determination of the optimal solution done by checking the extreme points one by one by way of an iterative calculation. So that the determination of the optimal solution with simplex is done step by step called iteration. In an iterative calculation, we will work using tables.
Iterative calculations in simplex are basically checking one by one extreme point worthy of completion [6].

In an effort to optimize every use of production factors, there will certainly be obstacles that arise, among others, from production factors such as raw materials, machinery, and labor that have limited capacity [5].

The Bintang Bakery home industry in the Lampung city volunteer, in the bread production process, has several constraints in producing three different types of bread, namely bread flavor \(x_1\), mattress bread \(x_2\), and white bread \(x_3\). The material used to produce bread is, of course, many types and in large scale. These ingredients have not been maximally utilized. The use of production machines which of course has limitations in terms of operating hours and the limitations of labor hours that have been set by the company with the workday of eight hours. This has become a necessity from the company to be able to allocate the available resources as much as possible.

When the supply of resources has not been maximally utilized, the profits obtained are not maximized. This is because the Bakery star’s home industry has not implemented linear programming and lack of understanding of mathematics in the production process that is done. Home Industry star Bakery conducts production planning using an approximate method of purchasing raw materials. This is one of the causes of not achieving maximum profits so that in the production process it is necessary to use linear programming to be able to use production inputs efficiently.

To facilitate and accelerate the completion of the calculation of the linear programming mathematical model is assisted by using a computer program application. Lindo is a computer program that is used to solve linear programming problems [7].

This research has been carried out by several people, namely Yulianti Siadari, with the title of the research is Optimization of the Advantages in the Production of Crepe Industry in Bandar Lampung PU Gang (Case Study at the Palace of Chips Mery Mother), and An-Saryoko with the title of research Me-tode Simplex in Optimizing Production Results. The research that will be conducted this time has three variables by using the simplex method. In this study, the production factors used are raw materials, production machines, and labor hours using Lindo tools.

2. Research Methods

This research is a literature study which is a review of the literature by examining books, literature, notes, and reports relating to the problems solved [8, 9] The steps that researchers will take to obtain data from the production process are as follows:

1. Interview
   An interview is a data collection technique in a survey method that asks questions orally to respondents.

2. Observation
   Observation is a technique of collecting data by observing ongoing activities.

2.1 Linear Programming

Standard linear programming problems. Maximum or minimum:

\[ Z = c_1x_1 + c_2x_2 + c_3x_3 + \cdots + c_nx_n \]

Limiting resources (constraints):

\[ a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \cdots + a_{1n}x_n = \leq/\geq b_1 \]
\[ a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + \cdots + a_{2n}x_n = \leq/\geq b_2 \]
\[ a_{m1}x_1 + a_{m2}x_2 + a_{m3}x_3 + \cdots + a_{mn}x_n = \leq/\geq b_m \]
\[ x_1, x_2, x_3, \ldots, x_n \geq 0 \]

Symbol \(x_1, x_2, x_3, \ldots, x_n\) shows decision variables, number of decision variables \((x_i)\) therefore depending on the number of activities or activities carried out to achieve the goal. Symbol
$c_1, c_2, c_3, ..., c_n$ is the contribution of each decision variable to the goal, also called the objective function coefficient on the mathematical model. Symbol $a_{11}, ..., a_{1n}, ..., a_{mn}$ is the use per unit of the limitation variable of resources which limits or is called the constraint function coefficient on the mathematical model. Symbol $b_1, ..., b_2, ..., b_m$ shows the number of each available resource. The number of constraint functions will depend on the limited number of resources. The last inequality $(x_1, x_2, ..., x_n \geq 0)$ shows non-negative limits.

2.2 Simplex Method

The simplex method is a solution to the problem of linear programming by finding a feasible solution, and using an iterative procedure, developing solutions to an optimal solution [6]. (The simplex method starts with a feasible point and tests whether the value of the objective function is optimal. If this is not the case, then this method continues at a better point. It is said to be better because, at a new point, the value of the objective function is usually close to optimal. If this new point does not provide optimal value, we repeat the procedure. In the end, the simplex method will produce an optimal value if it exists [10].

The general form of the objective function equation to maximize is:

$$Z = c_1x_1 + c_2x_2 + ....$$

Where:

$Z = $ maximum profit

$c_j =$ product profit contribution to-j

$x_j =$ product group to-j

The simplex table forms are as follows:

| Basic variable | $X_1$ | $X_2$ | $X_n$ | $S_1$ | $S_2$ | $S_n$ | NK |
|----------------|------|------|------|------|------|------|----|
| $Z$            | $-c_1$ | $-c_2$ | $...$ | $-c_n$ | 0    | 0    | 0  |
| $S_1$          | $a_{11}$ | $a_{12}$ | $...$ | $a_{1n}$ | 1    | 0    | 0  | $b_1$ |
| $S_2$          | $a_{21}$ | $a_{22}$ | $...$ | $a_{2n}$ | 0    | 1    | 0  | $b_2$ |
| $...$          | $...$ | $...$ | $...$ | $...$ | $...$ | $...$ | $...$ |
| $S_n$          | $a_{m1}$ | $a_{m2}$ | $...$ | $a_{mn}$ | $...$ | $...$ | 1  | $b_m$ |

Information:

$Z =$ the objective function is the optimal value (maximum, minimum)

$c_n =$ coefficient of profit per product package for each $x_n$

$x_n =$ decision variable to-n

$S_n =$ slack variable to-n

$a_{(mn)} =$ resource requirements for each $x_n$

$b_m =$ the number of resources available

$n =$ the number of decision variables starts from 1, 2, ..., n

$m =$ the number of types of resources used start from 1, 2, .. m

3. Results and Discussion

This research was conducted at the star Bakery home industry, Sukarame, Bandar Lampung. This business produces three types of products, namely flavored bread, mattress bread, and fresh bread. This flavored bread has six flavors, namely chocolate flavor, chocolate cheese flavor, pineapple flavor, blueberry flavor, cheese milk flavor, and strawberry flavor. The price in each package of bread is Rp.
2,500. Bread mattress has three flavors in one bread because it has a larger size. The taste in the bread is the mixing of chocolate flavor, chocolate cheese flavor, pineapple flavor, blueberry flavor, cheese milk flavor, and strawberry flavor. The price in each package of bread is Rp. 6,000. Tawar Bread does not have a flavor variant, in this one bread packaging, there are 12 pieces of bread. The price in each package of bread is Rp. 5,000.

The steps in the production process are as follows:
1. Preparation of raw materials
2. Stirring ingredients / making a dough
3. Distribution of bread
4. Filling bread
5. Grilling bread
6. Bread packaging

Based on the results of the interviews that researchers did directly to the resource persons who were the owners of the ground coffee business, they will be presented in table 2 of the production data for the one-month period as follows:

| Num. | Production Factor       | Availability | Unit |
|------|-------------------------|--------------|------|
| 1.   | Raw material            |              |      |
|      | Flour                   | 400          | Kg   |
|      | Sugar                   | 250          | Kg   |
|      | Developer               | 90           | Kg   |
|      | Softener                | 40           | Kg   |
|      | Yellow Butter           | 90           | Kg   |
|      | Salt                    | 10           | Kg   |
|      | Milk powder             | 60           | Kg   |
|      | Liquid milk             | 60           | Kg   |
|      | Butter BOS              | 90           | Kg   |
|      | Egg                     | 70           | Kg   |
|      | Feeling                 | 200          | Kg   |
|      | White butter            | 90           | Kg   |
|      | Calcium                 | 20           | Kg   |

| 2.   | Production machine      |              |      |
|      | Mixer                   | 20           | Hour |
|      | Divider machine         | 7            | Hour |
|      | Oven                    | 105          | Hour |

| 3.   | Labor Hours             | 208          | Hour |

Source: Bintang Bakery home industry, 2018

Bintang Bakery home industry will produce three types of bread, namely bread flavor, bread, and bread. In 1 package, the processing of flavored bread is needed 28 grams of flour, 7 grams of sugar, 1 gram of developer, 1 gram of softener, 5 grams of yellow butter, 1 gram of salt, 1 gram of powdered milk, 5 grams of liquid milk, 5 grams of butter, 4 grams of egg and 14 grams of flavor. Mattress bread needs 100 grams of flour, 25 grams of sugar, 9 grams of developer, 6 grams of softener, 20 grams of yellow butter, 3 grams of salt, 3 grams of powdered milk, 20 grams of liquid milk, 20 grams of BOS butter, 15 grams of egg and 20 grams taste. Whereas for bread is needed 250 grams of flour, 62 grams of sugar, 4 grams of a developer, 2 grams of softener, 50 grams of yellow butter, 2 grams of powdered milk, 25 grams of egg, 50 grams of white butter and 2 grams of calcium.

Home industry star Bakery only has flour less than 400 kg, sugar less than 250 kg, developer less than 90 kg, softener less than 40 kg, yellow butter less than 90 kg, salt less than 10 kg, milk powder less
than 60 kg, liquid milk less than 60 kg, BOS butter less than 90 kg, eggs less than 70 kg, flavorless less than 200 kg, white butter less than 90 kg, calcium less than 20 kg. The machine working hours used for one package produced 32 seconds of sweet bread, 132 seconds of bread and 336 seconds of bread. Engine working hour capacity in a one-month period is less than 475,200 seconds. Labor hours in one package produced 65 seconds of sweet bread, 209 seconds of sandwich bread and 450 seconds of bread. Labor hour capacity in a one-month period is less than 748,800 seconds. The selling price per pack of flavored bread is Rp. 2500, bread bed is Rp. 6000 and bread are Rp. 5000. So how much each bread will be produced to produce the maximum profit if the production limit of each bread is 3640 packs, 1300 packs, and 520 wraps?

Completion of the simplex method:
Solving the above problems and to find an optimization model of profit on the Bakery star home industry, use the following steps:

1. Determine the decision variables in solving linear program problems, namely the types of bread produced in the Bakery star home industry:
   \[ x_1 = \text{Bintang Bakery flavor} \] (3640 packs)
   \[ x_2 = \text{Bintang Bakery mattress} \] (1300 packs)
   \[ x_3 = \text{Bintang Bakery bargain} \] (520 packs)

2. Determine the constraints in the problem:
   - Flour: \[ 28x_1 + 100x_2 + 250x_3 \leq 400,000 \]
   - Sugar: \[ 7x_1 + 25x_2 + 62x_3 \leq 250,000 \]
   - Developer: \[ x_1 + 9x_2 + 4x_3 \leq 90000 \]
   - Softener: \[ x_1 + 6x_2 + 2x_3 \leq 40000 \]
   - Yellow butter: \[ 5x_1 + 20x_2 + 50x_3 \leq 90000 \]
   - Salt: \[ x_1 + 3x_2 \leq 10000 \]
   - Milk powder: \[ x_1 + 3x_2 + 2x_3 \leq 60000 \]
   - Liquid milk: \[ 5x_1 + 20x_2 \leq 60000 \]
   - BOS butter: \[ 5x_1 + 20x_2 \leq 90000 \]
   - Egg: \[ 4x_1 + 15x_2 + 25x_3 \leq 70000 \]
   - Feeling: \[ 14x_1 + 20x_2 \leq 200000 \]
   - White butter: \[ 5x_3 \leq 90000 \]
   - Calcium: \[ 2x_3 \leq 20000 \]
   - Production machine: \[ 32x_1 + 132x_2 + 336x_3 \leq 475200 \]
   - Labor: \[ 65x_1 + 209x_2 + 450x_3 \leq 748800 \]

3. Determine the objective function of the problem.
   \[ Z = 2500x_1 + 6000x_2 + 5000x_3 \]

4. Change the inequality (\(\leq\)) to be (\(=\)) by adding slack variables and artificial variables for inequality (\(\geq\)) to the left side of the obstacle.
   \[ 28x_1 + 100x_2 + 250x_3 + S_1 = 400000 \]
   \[ 7x_1 + 25x_2 + 62x_3 + S_2 = 250000 \]
   \[ x_1 + 9x_2 + 4x_3 + S_3 = 90000 \]
   \[ x_1 + 6x_2 + 2x_3 + S_4 = 40000 \]
   \[ 5x_1 + 20x_2 + 50x_3 + S_5 = 90000 \]
   \[ x_1 + 3x_2 + S_6 = 10000 \]
   \[ x_1 + 3x_2 + 2x_3 + S_7 = 60000 \]
   \[ 5x_1 + 20x_2 + S_8 = 600000 \]
   \[ 5x_1 + 20x_2 + S_9 = 90000 \]
5. Creating a simplex table by entering all the coefficients of the decision variables and the slack variables.

6. Then iterates (attachment) to find the maximum $Z$ value. From the results of calculations using an iteration, a new table will be obtained.

The results of the production optimization model processing show that the production carried out by the Bakery star home industry in factual conditions are not optimal. This can be seen from the condition of the total production that is different from the optimal conditions.

### Table 3 Optimal Bintang Bakery Production

| Num. | Bread type  | Variable | Production Level |
|------|-------------|----------|------------------|
| 1    | Taste bread | $x_1$    | 3640             |
| 2    | Bread mattress | $x_2$ | 1300             |
| 3    | White bread  | $x_3$    | 520              |

Source: Data Processed, 2018.

Based on table 3 the results of processing the production optimization model on the Bakery star home industry in factual conditions have not shown optimal results. This is shown by the results produced in factual conditions different from the results obtained in optimal conditions. In factual conditions, there were 3640 flavored Bakery stars, 1300 star Bakery mattresses, and 520 tasteless Bakery stars. 3740 flavored Bakery stars, 1300 Bakery stars, and 520 Bakery stars were obtained for optimal conditions.

### Table 4 Earnings of Each Product in Factual Conditions and Optimal Conditions

| No  | Bread type  | Variable | Production Level |
|-----|-------------|----------|------------------|
| 1   | Taste bread | $x_1$    | 9.100.000        |
| 2   | Bread mattress | $x_2$ | 7.800.000        |
| 3   | White bread  | $x_3$    | 2.600.000        |
|     | Total       |          | 19.500.000       |

Source: Data Processed, 2018.

Profit optimization calculations using the simplex method, get optimal results if the home industry produces 3740 packs of flavored Bakery stars, 1300 star Bakery mattresses, and 520 packaged Bakery stars, Rp. 19,750,000 obtained. If the Bakery star home industry produces each type of bread according to optimal results, the benefits that will be obtained will get optimal results. The optimal results obtained are Rp. 19,750,000 while the optimal results obtained from factual conditions are Rp. 19,500,000. The benefits obtained from factual conditions to optimal conditions are increased by Rp. 250,000.
4. Conclusion

Based on calculations using the linear programming simplex method and using the help of Lindo software, the optimum gain optimization model is obtained by producing flavored bread \((x_1)\) as much as 3740 packaging, bread mattress \((x_2)\) 1300 packs and bread \((x_3)\) as many as 520 packs. With each bread produced, the profit gained becomes Rp. 19,750,000 and the increase in profit obtained is Rp. 250,000. The profit will reach Rp. 19,750,000 if all the goods are sold out and there is no increase in raw materials.

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