



Profit Optimization and Production of Maesa Cake and Bakery Shops with Linear Programming-Simplex Method

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ABSTRACT: The need for cake as a complementary food at various events causes the demand to increase. This increase has an impact on the production level that will be produced with the aim of increasing profits. The production process is related to the allocation of the right raw materials to be efficient, so that maximum profits will be obtained. This study aims to analyze the maximum profit of the Maesa Cake and Bakery Shop, Permata Legenda Branch. There are two types of products sold in this shop, namely Banana Bolu (X1) and Banana Bolen (X2). The research method used is linear programming which is solved by the simplex method and the use of the POM For Windows application. The data obtained is observational data by meeting the shop owner directly to be interviewed. The process of calculating the simplex method is carried out using Ms. Excel with several completion steps, starting from creating a simplex table, entering the coefficients of the objective function and constraints, looking for key columns, key rows, and key numbers, until the last step is achieving positive coefficients generated in the objective function row. The final result obtained is the process of the iterations carried out. Apart from using Ms. Excel, researchers also use the POM for Windows application. Use both software to find the maximum profit to be achieved. So it is found that the maximum profit that can be obtained in one day by the Maesa Cake and Bakery Branch of Permata Legenda is IDR 270,000.00; by producing 5 units of Banana Bolu and 50 units of Banana Bolen.

KEYWORDS: Linear Programming, Simplex Method, POM for Windows

INTRODUCTION

Business competition is showing increasingly its existence in the economic world. Business is activity that aims to generate profit as much as possible(1). So that, sustainability is very important for the community to serve as a source of income. There are many types of businesses that currently develop. One of them is the development of business in producing cakes. Cake is a sweet food made from flour, sugar and eggs. People really like it for consumption. But it turns out that cake can also be used as a gift or complementary food at certain events, such as engagement events, recitations, and so on. These factors make the demand for cakes increase and entrepreneurs engaged in this field compete to produce cakes. In cake production activities, the allocation of raw materials is very important to determine the quantity of each type of cake to be made so that maximum profit can be achieved.

There are not a few Indonesians who do not know the Netherlands. This country has colonized Indonesia as long 350 years and the impact of this colonization is that Dutch culture has been brought into Indonesia. Lots of Indonesian culture that derivation and originate from Dutch culture.

One of them is Dutch food, Bolen Bread. Bolen bread is a typical Indonesian bread which is famous for its inner shape which has crispy layers. Even though bread is typical of Indonesia, this bolen bread is a processed flour food which is said to be proof of the influence of European culture. This type of bolen cake is also included in pastry cakes. So based on history, this bread comes from the Netherlands, known as bananenbollen (in Dutch). Apart from that, Bolen brad also has a variety of fillings, namely chocolate, cheese, chocolate cheese bananas, and others.

Maesa Cake and Bakery is a business that produces processed flour products. This business is a family business. Maesa Cake and Bakery Branch of Permata Legenda is one of the outlets that just opened on December 31, 2021. The location is on Jl. Asem Raya No. 1 RT. 004/RW. 006, Mustika Jaya, Kec. Mustikajaya, Bekasi City, West Java 17158. Maesa Cake and Bakery Branch Legend is a business owned by Mr. Ahmad Widodo and Mr. Suwarno with a consignment system. The consignment system is a form of business cooperation. This form of cooperation involves owners and dealers with the aim of mutual benefit. Cake products that are very popular according to the owner are Banana Bolu and Banana Bolen. The large number of requests for these two types of cakes to be used as food or delivery for certain events, such as weddings and recitations results in different volumes of



- Constraint function: sign \leq is changed to equation form and adds a slack variable (if the objective function is maximum) or a surplus variable (if the objective function is minimum) whose amount depends on the number of constraint functions.
 - Objective function: change from explicit to implicit form and add slack variables as well. However, in the objective function the slack variable is written zero because it does not contribute.
- ✓ Create a simplex table by entering the coefficients of each constraint function and objective function.
- ✓ The completion step is carried out (the settlement can be achieved if the coefficient of the objective function does not give a negative value).
- Set the key column by looking for the largest negative value in the Z row or objective function row.
 - Dividing NK by the number in each row of the key column and looking for the smallest value to be used as the key row.
 - Specifies the key number.
 - Dividing the key row by the key number (thus producing a new key row).
 - For rows other than key rows, the calculation of the new row is the old row – (coefficient in the key column x the new value of the key row).

Software POM for Windows

POM for Windows software is a type of application or it can be said that software is used to solve linear programs using the simplex method. This application has the function of seeking the optimum profit that can be obtained with a certain production level. The results obtained can provide precise and fast accuracy. POM-QM for Windows can perform quantitative calculations related to production in the field of operations management, science management, or operations research. This software provides a number of modules that can solve various problems such as Linear Programming, Forecasting, Decision Analysis, Project Management (PERT/CPM), and others.

RESEARCH METHOD

In conducting research, there are some steps used, namely:

1. Identification of problems

Researchers conducted this research due to problems that arose related to the limited availability of raw materials in the process of making two products, namely Banana Bolu and Banana Bolen.

2. Problem Solving Models

In this research, using a linear programming model which is solved by the simplex method so that maximum profit can be obtained.

3. Data collection

The data collected as quantitative data obtained by direct observation at the research location, namely the Maesa Cake and Bakery Shop, Permata Legenda Branch and by interviewing the owner of business. The questions asked regarding the main raw materials used for producing of these two products, namely Banana Bolu and Banana Bolen.

4. Data Processing and Analysis

The data that has been obtained is processed using Ms. Excel and POM software for windows.

5. Model Implementation

In this step, the simplex method calculation process is carried out on Ms. Excel by creating a simplex table, namely entering each coefficient of the objective function and constraints.

6. Evaluation of results

At this stage, it is done by comparing the solutions obtained using Ms. Excel and POM for Windows software for further analysis.

ANALYSIS AND DISCUSSION

In produce of Banana Bolu and Banana Bolen, the main raw material is banana flour. The availability of wheat flour in a day to produce both types of cakes is no more than 8.5 kilograms. As for bananas that must be available in one day is as much as



14 bunch of banana. The bananas needed to make each unit of Banana Bolu and Banana Bolen are 0.2 of buch and 0.25 of buch. For the use of wheat flour in the produce of each unit of Banana Bolu and Banana Bolen is as much as 0.15 kilograms and 0.2 kilograms. Obtained data as follows:

Table 2. Ingredient, demad and capacity

| Product | Wheat flour (kg) | Banan (Bunch) | Demand (unit) |
|-------------------|------------------|---------------|---------------|
| Banana Bolu (X1) | 0,2 | 0,2 | 5 |
| Banana Bolen (X2) | 0,15 | 0,25 | 50 |
| Capacity | 8,5 | 14 | |

The profit for 1 unit of Banana Bolu is IDR.4000,- while for 1 unit of Banana Bolen is IDR.5000,-

Linear Program Model

Objective fuction: Maximize profits

$$Z = 4000 X1 + 5000 X2$$

Constraint function:

- 1) $0,2 X1 + 0,15 X2 \leq 8,5$
- 2) $0,2 X1 + 0,25 X2 \leq 14$
- 3) $X1 \leq 5$
- 4) $X2 \leq 50$
- $X1, X2 \geq 0$

Simplex Model

$$Z - 4000 X1 - 5000 X2 - 0S1 - 0S2 - 0S3 - 0S4 = 0$$

With constraints:

- 1) $0,2 X1 + 0,15 X2 + 1S1 = 8,5$ (Wheat flour)
- 2) $0,2 X1 + 0,25 X2 + 1S2 = 14$ (Banana)
- 3) $X1 + 1S3 = 5$ (Demand estimate of Banana Bolu)
- 4) $X2 + 1S4 = 50$ (Demand estimate Banana Bolen)
- 5) $X1, X2, S1, S2, S3, S4 \geq 0$

Completion:

a. Enter the coefficients of the objective function and constraints into the simplex table whose format has been created.

Table 3. Inputting data in simplex table

| Simplex Table | | | | | | | | |
|----------------|---|-------|-------|----|----|----|----|-----|
| Base Variables | Z | X1 | X2 | S1 | S2 | S3 | S4 | NK |
| Z | 1 | -4000 | -5000 | 0 | 0 | 0 | 0 | |
| S1 | 0 | 0.2 | 0.15 | 0 | 0 | 0 | 0 | 8.5 |
| S2 | 0 | 0.2 | 0.25 | 0 | 0 | 0 | 0 | 14 |
| S3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 |
| S4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 50 |

(Calculation by Ms. Excel)

b. Perform calculations based on the simplex method, namely by iteration until the objective function is not negative.



Table 4. First iteration of simplex

| Iteration-1 | | | | | | | | | |
|---------------|---|-------|-------|----|----|----|----|-----|---------|
| base variable | Z | X1 | X2 | S1 | S2 | S3 | S4 | NK | |
| Z | 1 | -4000 | -5000 | 0 | 0 | 0 | 0 | | |
| S1 | 0 | 0.2 | 0.15 | 0 | 0 | 0 | 0 | 8.5 | 56.6667 |
| S2 | 0 | 0.2 | 0.25 | 0 | 0 | 0 | 0 | 14 | 56 |
| S3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | |
| S4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 50 | 50 |

(Calculation by Ms. Excel)

In the iteration 1 table above, we must be able to determine the largest negative number in row z or the objective function, which is located in column X2. So column X2 is the key column. Then the next step is to divide the NK in each row of the key column and the smallest result is found in row S4. So the number one is the key figure and becomes the divisor for row S4.

Table 5. Second iteration of simplex

| Iteration-2 | | | | | | | | | |
|---------------|---|-------|----|----|----|----|----|--------|-----|
| Base Variable | Z | X1 | X2 | S1 | S2 | S3 | S4 | NK | |
| Z | 1 | -4000 | 0 | 0 | 0 | 0 | 0 | 250000 | |
| S1 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 1 | 5 |
| S2 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 1.5 | 7.5 |
| S3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 5 |
| X2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 50 | |

(Calculation by MS. Excel)

In the iteration 2 table above, row z or the objective function is still negative, therefore the calculation will continue until iteration 3. So column X1 becomes the key column. Then, the result of the smallest division between each NK (Right Value) with each key column row is row S1. So 0.2 is the key number because it is the point of intersection and it is the divider for row S1.

Table 6. Third iteration of Simplex

| Iteration-3 | | | | | | | | | |
|---------------|---|----|----|----|----|----|----|--------|--|
| Base Variable | Z | X1 | X2 | S1 | S2 | S3 | S4 | NK | |
| Z | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 270000 | |
| X1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | |
| S2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | |
| S3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| X2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 50 | |

(Calculation by Ms. Excel)

In iteration 3, it has been found that the row of Z or the objective function has produced a non-negative value. So the solution has been reached, where the maximum profit achieved is IDR. 270,000, 5 Banana Bolu and 50 Banana Bolen.

Using POM-QM Software

Steps computation of POM-QM as follow:

1. Open the POM-QM Application that has been downloaded on the Desktop.

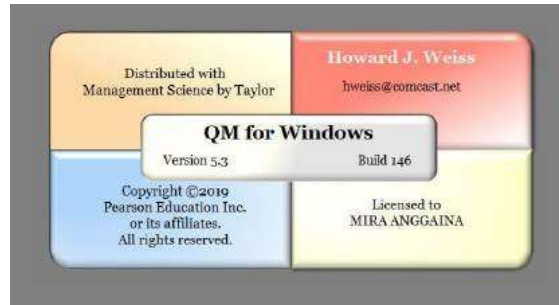


Figure 1. Initial View of POM-QM Software Versi 5.3

2. Main screen display

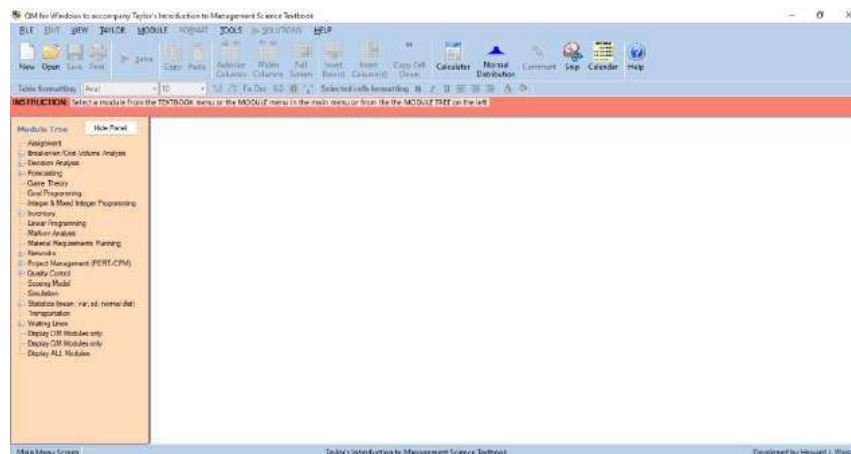


Figure 2. View of POM menu

3. On the Module Tree menu, select and click Linear Programming, then it will appear as below.

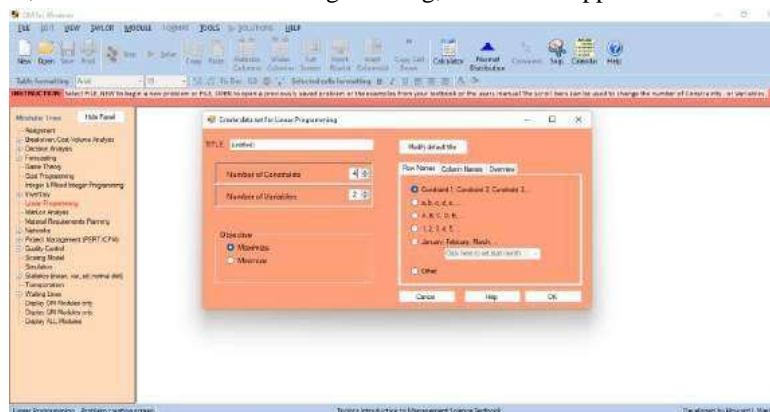
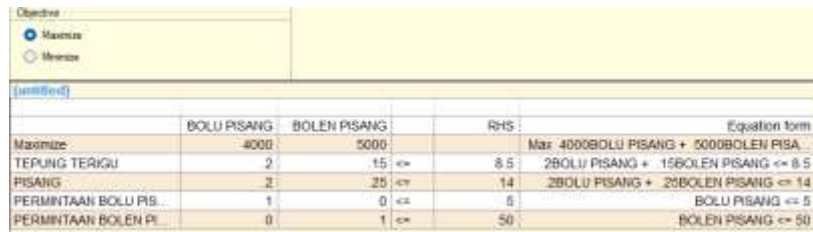


Figure 3. Start to Linear Programming

Fill in the Number of Constraints menu according to the number of constraints (ie 4) and in the Number of Variables menu according to the number of variables (ie 2).

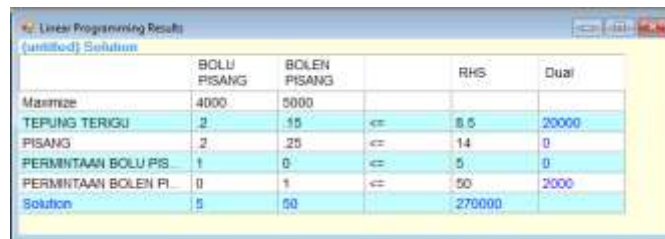
4. Fill in the variables and constraints according to the linear program model.



| | BOLU PISANG | BOLEN PISANG | | RHS | Equation form |
|----------------------|-------------|--------------|----|-----|---|
| Maximize | 4000 | 5000 | | | Max 4000BOLU PISANG + 5000BOLEN PISA... |
| TEPUNG TERIGU | 2 | 15 | <= | 8.5 | 2BOLU PISANG + 15BOLEN PISANG <= 8.5 |
| PISANG | 2 | 25 | <= | 14 | 2BOLU PISANG + 25BOLEN PISANG <= 14 |
| PERMINTAAN BOLU PIS. | 1 | 0 | <= | 5 | BOLU PISANG <= 5 |
| PERMINTAAN BOLEN PI. | 0 | 1 | <= | 50 | BOLEN PISANG <= 50 |

Figure 4. Inputting data to Linear Programming

5. Click the Solve Icon and the following results are obtained:



| | BOLU PISANG | BOLEN PISANG | | RHS | Dual |
|----------------------|-------------|--------------|----|--------|-------|
| Maximize | 4000 | 5000 | | | |
| TEPUNG TERIGU | 2 | 15 | <= | 8.5 | 20000 |
| PISANG | 2 | 25 | <= | 14 | 0 |
| PERMINTAAN BOLU PIS. | 1 | 0 | <= | 5 | 0 |
| PERMINTAAN BOLEN PI. | 0 | 1 | <= | 50 | 2000 |
| Solution | 5 | 50 | | 270000 | |

Figure 5. Result of Linear Programming



| Variable | Status | Value |
|-------------------|----------|--------|
| BOLU PISANG | Basic | 5 |
| BOLEN PISANG | Basic | 50 |
| slack 1 | NONBasic | 0 |
| slack 2 | Basic | .5 |
| slack 3 | Basic | 0 |
| slack 4 | NONBasic | 0 |
| Optimal Value (Z) | | 270000 |

Figure 6. Final result of computation



| Cj | Basic Variables | Quantity | 4000 BOLU PISANG | 5000 BOLEN PISANG | 0 slack 1 | 0 slack 2 | 0 slack 3 | 0 slack 4 |
|--------------------|-----------------|----------|------------------|-------------------|-----------|-----------|-----------|-----------|
| Iteration 1 | | | | | | | | |
| 0 | slack 1 | 8.5 | 0.2 | 0.15 | 1 | 0 | 0 | 0 |
| 0 | slack 2 | 14 | 0.2 | 0.25 | 0 | 1 | 0 | 0 |
| 0 | slack 3 | 5 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | slack 4 | 50 | 0 | 1 | 0 | 0 | 0 | 1 |
| | zj | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | zj-cj | | 4000 | 5000 | 0 | 0 | 0 | 0 |
| Iteration 2 | | | | | | | | |
| 0 | slack 1 | 1.0 | 0.2 | 0 | 1 | 0 | 0 | -0.15 |
| 0 | slack 2 | 1.5 | 0.2 | 0 | 0 | 1 | 0 | -0.25 |
| 0 | slack 3 | 5 | 1 | 0 | 0 | 0 | 1 | 0 |
| 5000 | BOLEN PI. | 50 | 0 | 1 | 0 | 0 | 0 | 1 |
| | zj | 250000 | 0 | 5000 | 0 | 0 | 0 | 5000 |
| | zj-cj | | 4000 | 0 | 0 | 0 | 0 | -5000 |
| Iteration 3 | | | | | | | | |
| 4000 | BOLU PIS. | 5.0 | 1 | 0 | 5.0 | 0 | 0 | -0.75 |
| 0 | slack 2 | 0.5 | 0 | 0 | -1 | 1 | 0 | -0.1 |
| 0 | slack 3 | 0.0 | 0 | 0 | -5.0 | 0 | 1 | 0.75 |
| 5000 | BOLEN PI. | 50 | 0 | 1 | 0 | 0 | 0 | 1 |
| | zj | 270000 | 4000 | 5000 | 20000 | 0 | 0 | 2000 |
| | zj-cj | | 0 | 0 | -19999.9 | 0 | 0 | -1999.99 |

Figure 7. View of iteration process

As result computing by POM for windows, its achieved that Maximum profit as IDR.270.000, with produced Banana Bole as much as 5 units and Banana Bolen as much as 50 units. By this result, it is confirmed that manual computation by excel is right.



CONCLUSSION

Based on the results of analysis and calculations using Microsoft Excel and POM-QM software, it can be concluded that POM-QM software can perform calculations quickly and accurate results. The same results were found between calculations using Microsoft Excel and POM-QM, that the maximum profit that can be obtained at the Maesa Cake and Bakery Branch Legend Bakery is IDR 270,000.00 by selling 5 units of Banana Bolu and 50 units of Banana Bolen.

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