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PROFIT OPTIMIZATION IN WET CAKE SALES USING THE SIMPLEX METHOD AND ITS APPLICATION IN POM-QM

Farica Luthfiyah[1], Riska Aulia[2], Muhammad Irfan[3], Adinda Wahyu Nuraini[4], Muhammad Firliansyah Purba[5]

[1,2,3,4,5]Department of Mathematics, Universitas Islam Negeri Sumatera Utara, Medan, Indonesia

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ABSTRACT

The development of population increases every year causing food needs to increase, to meet food needs by increasing food crop productivity so that food availability can be sufficient. Food crops consist of rice, corn, green beans, peanuts, cassava, and sweet potatoes. Productivity in each region has different characteristics and therefore it is necessary to group the regions so that solution can be implemented in accordance with each of the characteristics of the region. The purpose of this study is to group districts/cities in North Sumatera Province based on food crop productivity using the k-means clustering method. Clustering k-means is method of grouping non-hierarchical data that attempts to partition existing data into one or more cluster or groups so that data that has the same characteristics are grouped into one same characterstics are grouped into other groups. The result of this study are the formation of 3 city district clusters namely, cluster 1 amounting to 1 regency/city, cluster 2 totaling 7 districts/cities, and cluster 3 totaling 25 districts/cities.

Corresponding Author:

Farica Luthfiyah,
Department Of Mathematic,
Universitas Islam Negeri Sumatera Utara Medan
Email: Email: faricaluthfiyah054@gmail.com

1. INTRODUCTION

Indonesia has a wealth of various types of snacks and cakes, both savory and sweet. Popular cakes include risoles, pastel, lumpia, lemper, lontong, tahu isi, lapis legit, getuk, bakpia, bika ambon, lupis, lemang, timpan, klepon, onde-onde, nagasari, soes, and bolu kukus. Indonesian traditional cakes can be found in traditional markets, which is why they are often referred to as "jajanan pasar" or traditional snacks. Traditional cakes are part of the traditional food category. A traditional cake is one that has become part of the Indonesian community's culture, made with ingredients that are traditionally sourced and have been passed down for generations. Specifically in certain regions or communities in Indonesia, traditional cakes are often made from recipes that are well known locally, using ingredients sourced from local resources that have flavors that align with the local taste preferences. Each region has its own traditional cakes, and each community will have its own diverse range of cakes, distinct from others in terms of ingredients and preparation methods. Wet cakes are also often called market food, and they are unique Indonesian traditional cakes that are incomparable anywhere else, making it hard for enthusiasts to switch preferences. Wet cakes are typically served not only as snacks but also during important events, such as weddings. Many cake entrepreneurs, both seasoned and new, profit from this market. The system

that regulates the production process, business management, and marketing must be structured so that the business runs smoothly and in line with the desired mechanisms. This way, business management can function efficiently, cleanly, and successfully, even if the company starts small. Expanding the variety of shapes, types, and flavors of wet cakes produced provides more choices for consumers. At the same time, packaging design must be as neat, clean, and attractive as possible. Packaging also plays a significant role in influencing consumer interest because an appealing and hygienic product presentation is key. Whether the cakes are wet or dry, expensive or inexpensive, entrepreneurs must be skilled in packaging and presenting the products with an attractive label. Traditional cakes and foods have a distinct flavor compared to foreign foods. Although foreign cuisines are widely present in Indonesia, traditional cakes have earned a place in the hearts of Indonesian people. In this business analysis, we are focusing on traditional wet cakes. When considering competitors in the same business, there are quite a few. By innovating with better flavors, attractive sizes, affordable prices, and, most importantly, ensuring that the cakes are healthy, hygienic, and packaged in an appealing way, our product can compete in the market and be successful.

2. RESEARCH METHOD

The type of research used in this study is quantitative research. The quantitative research method is a type of research that is systematic, planned, and clearly structured from the beginning through to the creation of the research design. Quantitative research is based on the philosophy of positivism, used to study a specific population or sample, data collection uses research instruments, and data analysis is quantitative/statistical, with the goal of testing the hypothesis that has been formulated (Sugiyono, 2011).
This research is a "case study" on the analysis of the profit from the production of wet cakes. In this research, several stages were conducted to obtain optimal results. The first stage is the preparation phase, which involves conducting a literature review to master the theory related to the concepts tied to the problem being studied. The second stage involves data collection, followed by identification.

3. RESULT AND ANALYSIS

Data
The sale of traditional cakes refers to the sale of various types of cakes, one of which is wet cakes. In this research, two types of wet cakes are used: rolled omelette cake (dadar gulung) and ongol-ongol.
Factors Affecting Wet Cake Production
The factors considered by the researcher as influencing the production of wet cakes are as follows:

1. Raw Materials

Table 1. Table of Raw Materials

Types of Raw Materials	Rolled Omelette Cake	Ongol-ongol
Flour	10 gr	10 gr
palm sugar	8 gr	5 gr
grated coconut	5 gr	3 gr

2. Raw Material Inventory

Table 2. Table of Raw Material Inventory

Types of Raw Materials	Daily Raw Material Inventory
Tepung	500 gr
Gula merah	300 gr
Kelapa parut	400 gr

3. Selling Price

Table 3. Table of Selling Price

Types of Cakes	Selling Price
$x1$	Rp 1.000
$x2$	Rp 1.000

Data Arrangement in Mathematical Model
The data used by the researcher includes raw materials, raw material inventory, and selling prices. The profit from the sale of traditional cakes is the objective function in this study. Meanwhile, the raw material inventory, and selling prices are part of the objective function. Based on relevant data, it is further detailed as follows:

Table 4. Table of raw traditional traditional cakes

Raw materials	Rolled omelette cake	Ongol-ongol	Inventory
Flour	10 gr	10 gr	500 gr
Palm sugar	8 gr	5 gr	300 gr
Grated coconut	5 gr	3 gr	400 gr
Price	Rp 1.000	Rp 1.000	

Objective function

$$\max Z = 1000_{X_1} + 1000_{X_2}$$

Constraint function

$$10_{X_1} + 10_{X_2} \leq 500$$
$$8_{X_1} + 5_{X_2} \leq 300$$
$$5_{X_1} + 3_{X_2} \leq 400$$

Where,

$$X_1 = Rolled\ Omelette\ Cake$$
$$X_2 = Ongol - ongol$$

Searching for the Solution of Constraints

1. Transform the objective function and constraint functions into canonical form.
   Maximize:
   $$Z = 1000_{X_1} + 1000_{X_2}$$
   Constraint Function:
   $$10_{X_1} + 10_{X_2} \leq 500$$
   $$8_{X_1} + 5_{X_2} \leq 300$$
   $$5_{X_1} + 3_{X_2} \leq 400$$
   Canonical Form:
   $$Z - 1000_{X_1} + 1000_{X_2} - 0_{S_1} - 0_{S_2} - 0_{S_3}$$
   $$10_{X_1} + 10_{X_2} = 500$$
   $$8_{X_1} + 5_{X_2} = 300$$
   $$5_{X_1} + 3_{X_2} = 400$$
2. Arrange the equations into a table

   Table 5. Table of the each value of canonical equation for iteration 1

Basis	Z	X_1	X_2	S_1	S_2	S_3	RHS	Ratio
Z	1	-1000	-1000	0	0	0	0	-
S_1	0	10	10	1	0	0	500	500/10=50
S_2	0	8	5	0	1	0	300	300/8=37,5
S_3	0	5	3	0	0	1	400	300/8=37,5

3. Determining the Key Column
   Based on table 5, the key column is x1, where there are two negative values with the largest number in the x1 and x2 columns. Therefore, we can choose one of these columns.
4. Selecting the Key Row
   Based on Table 5, the key row is s2, where the s2 row has the smallest ratio. This is determined by dividing each value in the RHS column by the corresponding value in the key column.
5. Determining the Pivot Point
   Based on Table 5, the pivot is 8, where this value represents the intersection of the key column and key row.
6. Changing the Values in the Table Based on the Key Column and Row
   Change the pivot value to 1 and set the other values in the key column to 0 using elementary row operations, and then adjust the other values in the table accordingly. Change the pivot value to 1 and set the other values in the key column to 0 using elementary row operations, and then adjust the other values in the table accordingly.

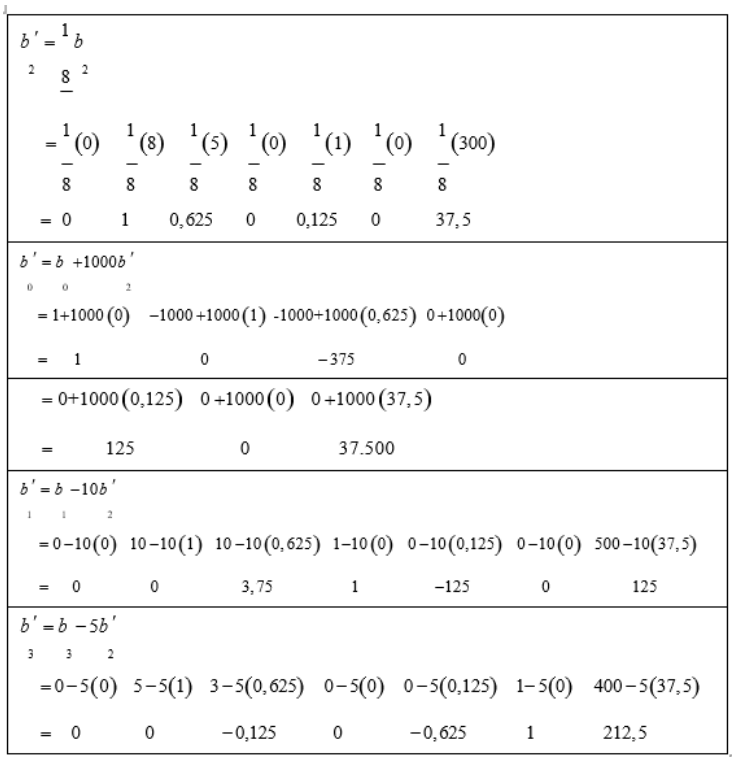


Figure 1 The solution for iteration 1

Iteration 2

Table 6 Table for iteration 2

Basis	Z	X_1	X_2	S_1	S_2	S_3	RHS	Ratio
Z	1	0	-375	0	125	0	37500	-
S_1	0	0	3,75	1	-1,25	0	125	125/3,75=33,33
X_1	0	1	0,625	0	0,125	0	37,5	37,5/0,625=60
S_3	0	0	-0,125	0	-0,625	1	212,5	-

7. Repeat the steps until there are no negative values in the objective function row

$$b'' = \frac{1}{3,75} b_1$$

$$= \frac{1}{3,75}(0) \quad \frac{1}{3,75}(0) \quad \frac{1}{3,75}(3,75) \quad \frac{1}{3,75}(1) \quad \frac{1}{3,75}(-1,25) \quad \frac{1}{3,75}(0) \quad \frac{1}{3,75}(125)$$

$$= 0 \quad 0 \quad 1 \quad 0,266 \quad 0,33 \quad 0 \quad 33,33$$

$$b_0' = b_0 + 375 b_1'$$

$$= 1+375(0) \quad 0+375(0) \quad -375+375(1) \quad 0+375(0,266)$$

$$= 1 \quad 0 \quad 0 \quad 99,75$$

$$= 125+375(0,33) \quad 0+375(0) \quad 37500+375(33,33)$$

$$= 248,75 \quad 0 \quad 49.998,75$$

$$b_2' = b_2 - 0,625 b_1'$$

$$= 0-0,625(0) \quad 1-0,625(0) \quad 0,625-0,625(1) \quad 0-0,625(0,266)$$

$$= 0 \quad 1 \quad 0 \quad -0,16625$$

$$= 0,125-0,625(0,33) \quad 0-0,625(0) \quad 37,5-0,625(33,33)$$

$$= -0,08125 \quad 0 \quad 16,66875$$

$$b_3' = b_3 + 0,125 b_1'$$

$$= 0+0,125(0) \quad 0+0,125(0) \quad -0,125+0,125(1) \quad 0+0,125(0,266)$$

$$= 0 \quad 0 \quad 0 \quad 0,3325$$

$$= -0,625+0,125(0,33) \quad 1+0,125(0) \quad 212,5+0,125(33,33)$$

$$= -0,58375 \quad 1 \quad 216,66625$$

Figure 2 The solution for iteration 2

Iteration 3

Table 7 Table for iteration 3

Basis	Z	X_1	X_2	S_1	S_2	S_3	RHS	Ratio
Z	1	0	0	99,75	248,75	0	49.998,75	-
X_2	0	0	1	0,266	0,33	0	33,33	-
X_1	0			-0,16625	-0,08125	0		-
S_3	0	0	0	0,03325	-0,58375	1	216,66626	-

8. Since there are no negative values in the objective function row, the iteration is considered optimal. The optimal results are as follows.
   $Z = 49.998,75 \approx 50.000$ (Profit)
   $X_1 = 16,66875 \approx 17$ (Rolled Omelette Cake)
   $X_2 = 33,33 \approx 33$ (Ongol-ongol)

9. Conclusion
   Thus, from the sale of traditional cakes, a daily profit of IDR 50,000 will be obtained by selling 17 dadar gulung and 33 ongol-ongol.

Profit Calculation Using POM-QM

1. Open the POM-QM application and sellect the *Linear Programing*.

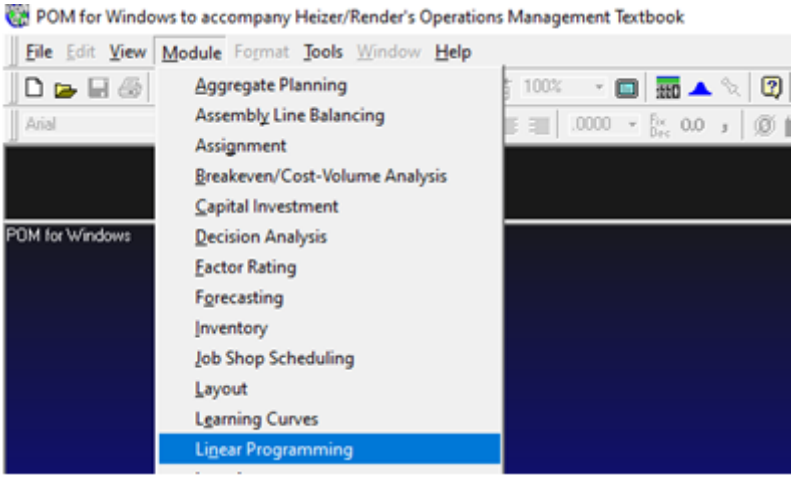


Figure 3 The display on POM – QM application

2. Click on File and New, enter the number of Constraints according to the number of constraints (in this study, it is raw materials) which is 3, and the number of Variables according to the number of product types, which is 2.

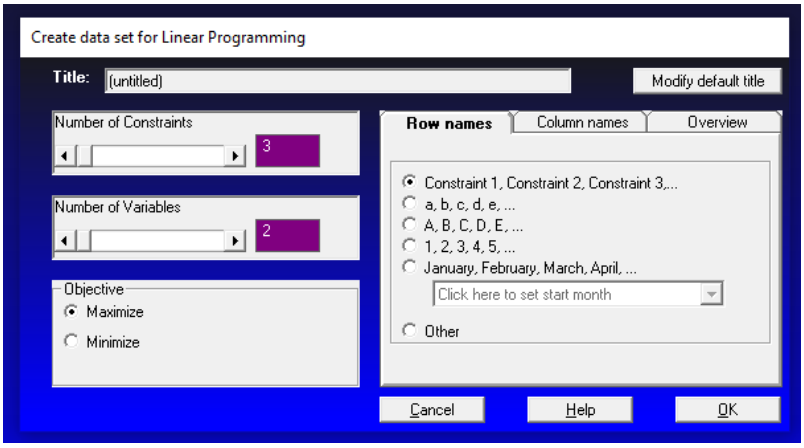
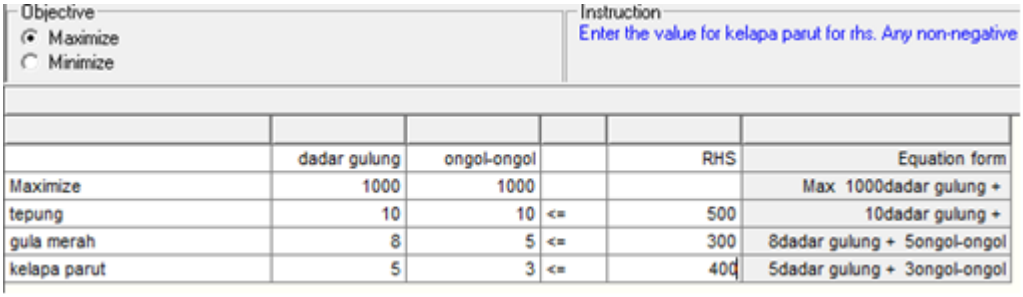


Figure 4 The display on data set of linear programming

3. Enter the raw material data, raw material inventory, and selling price into the POM-QM application.



	dadar gulung	ongol-ongol		RHS	Equation form
Maximize	1000	1000			Max 1000dadar gulung +
tepung	10	10	<=	500	10dadar gulung +
gula merah	8	5	<=	300	8dadar gulung + 5ongol-ongol
kelapa parut	5	3	<=	400	5dadar gulung + 3ongol-ongol

Figure 5 The display of equation traditional cake using POM QM application

4. Solve, check the results in the iteration section and result.

Cj	Basic Variables	1000 dadar	1000 ongol-ongol	0 slack 1	0 slack 2	0 slack 3	Quantity
Iteration 1							
0	slack 1	10	10	1	0	0	500
0	slack 2	8	5	0	1	0	300
0	slack 3	5	3	0	0	1	400
	zj	0	0	0	0	0	0
	cj-zj	1,000	1,000	0	0	0	
Iteration 2							
0	slack 1	0	3.75	1	-1.25	0	125
1000	dadar	1	0.625	0	0.125	0	37.5
0	slack 3	0	-0.125	0	-0.625	1	212.5
	zj	1000	625	0	125	0	37,500
	cj-zj	0	375	0	-125	0	
Iteration 3							
1000	ongol-ongol	0	1	0.2667	-0.3333	0	33.3333
1000	dadar	1	0	-0.1667	0.3333	0	16.6667
0	slack 3	0	0	0.0333	-0.6667	1	216.6667
	zj	1000	1000	100	0	0	50,000
	cj-zj	0	0	-100	0	0	

Figure 6 The display result for all iteration

Objective
Maximize
Minimize

Note
Multiple optimal solutions exist

Linear Programming Results

	dadar gulung	ongol-ongol		RHS	Dual
Maximize	1000	1000			
tepung	10	10	<=	500	100
gula merah	8	5	<=	300	0
kelapa parut	5	3	<=	400	0
Solution->	16.6667	33.3333		50000	

Figure 7 The figure of solution for each traditional cake production

Figure 6 it can be seen that there are 3 iteration tables, which are consistent with the ones manually calculated. With similar results, it shows that from the sale of traditional cakes, a daily profit of IDR 50,000 will be obtained by selling 17 dadar gulung and 33 ongol-ongol.

4. CONCLUSION

Based on the discussion above, the conclusions that can be drawn are:

1. The analysis shows that the application of linear programming using the simplex method in optimizing the profit from the sale of traditional cakes by Mrs. Yani can help maximize profits despite the limited resources (ingredients) available.
2. The maximum profit that can be obtained from the sale of Mrs. Yani's traditional cakes is IDR 50,000 per day.
3. The maximum profit of IDR 50,000 per day is achieved when selling 17 dadar gulung and 33 ongol-ongol.
4. By calculating the maximum profit using the simplex method and the POM-QM application, the calculation of traditional cake sales profit can be accelerated.

Recommendation

Based on the results obtained, the outcomes of this research are expected to benefit:

1. Sellers/business owners if Mrs. Yani wishes to increase the production of traditional cakes, the seller should consider production costs and further analyze the use of all available production capacity to ensure that production reaches maximum profit.
2. Future research using other methods, future studies can conduct trend analysis to support innovation, providing input for the sales force and production development.

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