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Profit Optimization of Sambal SohibKoe Using Linear Programming Simplex Method

Charles Nicole[1], Christopher Vergara Lidaya[2*], Dudy Effendy[3], Feby Lia[4], Felix Kharisma[5], Khefen[6], Meilisa Permata Wonowijaya[7]
Faculty of Economics and Business, Universitas Widya Dharma Pontianak
Corresponding Author: Christopher Vergara Lidaya
vergarachristopher910@gmail.com

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ABSTRACT

Mrs. Devi's Sambal business named "SohibKoe" is one of the businesses in the culinary field which is growing rapidly in Indonesia or what is commonly called Micro, Small and Medium Enterprises (UMKM). In this business, the problems faced are the price and limitations of raw materials and the number of customers also affect the increase in profits which makes Sambal run out quickly with an uncertain time which makes the profit earned not maximized. This research was conducted with the aim of formulating problem-solving in profit optimization in Micro, Small and Medium Enterprises (MSMEs) from Mrs. Devi's Sambal SohibKoe business. The simplex method is a way to solve linear programming problems where a repetition of mathematical procedures is carried out to test corner points so that an optimal solution is found. The data used in the research conducted is data obtained directly from interviews with Mrs. Devi as a seller of SohibKoe chili sauce. Based on research through the simplex method linear program, the results of optimization calculations obtained include stating that the maximum profit per week is 155,000 with a production amount of 8 bottles of Sambal cumi petai and 7 bottles of Sambal teri

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INTRODUCTION

The culinary industry is one of the business sector that is currently growing rapidly in Indonesia, especially in Micro, Small and Medium Enterprises (UMKM). Micro, Small and Medium Enterprises is a business that is operated by individual business actors, households, or small-scale business entities. Small, Micro, and Medium Enterprises (UMKM) is considered as businesses that is able to survive under any conditions, and by using modest capital so that every small business actor can run and develop this business from collecting raw materials, and production to marketing.

Other than that, the price and limited raw materials to produce Sambal also affect sales which can cause profits not to be maximized. One of them is Mrs. Devi's Sambal 'Sohibkoe' business in Pontianak, the number of customers also affects the increase in profits which makes the Sambal run out quickly with an uncertain time. Therefore, business actors must be able to make good plans and strategies in order to maximize the benefits obtained in the Sambal business.

In the case of Sambal Sohibkoe owned by Mrs. Devi, she can solve problems through linear programming with the simplex method, so that business actors can balance the existing production factors with the right production planning. With that way, business actors are expected to optimize the number of products in order to get maximum profit. The data needed for problem-solving by applying the simplex method as a constraint function and objective function. The researchers conducted research directly in the field. This research was conducted with the aim of formulating problem-solving in optimizing profits in the Micro, Small and Medium Enterprises (UMKM) of Sambal Sohibkoe owned by Mrs. Devi.

Sambal

One of the case studies of UMKM in the culinary field, is Sambal. Sambal is an indigenous tradition typical of the island of Java to make condiments or food flavorings, the word "Sambal" itself is actually an absorption word rooted in the ancient Javanese language, Sambel, which means "crushed" or "crushed", referring to the processing of crushed spices or chilies. The terminology can be traced in various ancient Javanese inscriptions and manuscripts found throughout the island of Java, some of which are the kidung Sri Tanjung (from the 12th century), the manuscript Serat Centini (from the 16th century), and so on.

The aim of this research is to optimize the profit of a small business selling chili sauce through linear programming using the simplex method. The problem being addressed is how to determine the optimal production of chili squid petai sauce and chili anchovy sauce to maximize profits. The study uses data obtained from interviews with the business owner and applies linear programming to find the optimal solution for maximizing profits. The results of the study can be used as a reference for managerial decision-making and contribute to the literature on linear programming and optimization in business and economics.

Ingredients that are used to make Sambal are: onions, shallots, garlic, Cayenne pepper, Mademe Jeanette pepper, Cayenne pepper, Lombok pepper, sugar, and shrimp paste. How to make chili sauce is very diverse, depending on the type. Sambals such as Sambal Matah are made with raw ingredients, which can be served raw or sautéed in cooking oil. Sambal Petis, Sambal Oncom, and Sambal Tempe are fermented. The cooking methods also vary, including scrambled, fried, sautéed, boiled, and grilled. The data in this study were obtained based on the results of interviews in field studies with Sambal sellers. The purpose of this study is to optimize production results by using a linear program through the simplex method in order to get maximum profit and become an analytical guide in making decisions. The research material assistance was obtained through literature studies based on research materials sourced from several articles.

THEORETICAL FRAMEWORK

1. Micro, Small, and Medium Enterprises (UMKM):
   - UMKM is rapidly growing from the culinary sector in Indonesia.
   - UMKM is operated by individual business actors, households, or small-scale business entities.
   - UMKM requires effective planning and resource allocation to maximize benefits.
2. Profit Optimization in UMKM:
   - Profit optimization is crucial for UMKM to ensure maximum profitability.
   - Price, raw materials, and customer demand significantly impact profit optimization.
   - Linear Programming with the simplex method can be used as a tool for optimizing profits in UMKM.
3. Linear Programming:
   - Linear programming helps operational managers make informed decisions and allocate resource efficiently
   - Linear programming is a mathematical technique used to allocate limited resource among competing activities.
   - Linear programming involves decision variables, objective functions, and constraint functions.
4. Simplex Method:
   - Simplex method is a mathematical procedure used to solve linear programming problems.
   - Simplex method tests corner points to find optimal solutions.
   - Simplex method can handle linear programming problems with multiple variables.

5. Sambal SohibKoe Case Study:
   - Sambal SohibKoe, owned by Mrs.Devi, is one of the UMKM culinary business specializing in chili sauce.
   - The business faces challenges such as limited raw materials and fluctuating customer demand.
   - Linear programming with the simplex method can be applied to optimize production and maximize profits.
6. Data Collection and Analysis:
   - The data for this research was collected through an interview with Mrs.Devi, the owner of Sambal SohibKoe
   - The research focuses on formulating problem-solving strategies for profit optimization.
   - The collected data is used as constraints and objective function in the linear programming model.
7. Steps in Applying the Simplex Method:
   - Identify decision variables and convert them into mathematical model.
   - Define the objective function and convert it into a mathematical representation.
   - Formulate constraint function by converting them into mathematical equations.
   - Construct the Simplex table and determine the key column and key row.
   - Perform iterations by changing decision variables and recalculating until an optimal solution is reached.
8. Results:
   - The research findings indicate the optimal production quantities for chili squid petai sauce (Sambal cumi petai) and chili anchovy sauce (Sambal teri).
   - The optimal solution leads to maximum profit for Sambal SohibKoe.
   - The results can serve a guide for managerial decision-making and contribute to the field of linear programming and optimization in business and economics.

METHODS

The data in this study were obtained based on the results of interviews in field studies to Sambal sellers. The purpose of this study is to optimize production results by using a linear program through the simplex method in order to get maximum profit and become an analytical guide in making decisions. The research material assistance was obtained through literature studies based on research materials sourced from several articles.

1. Linear Programming
   According to Heizer and Render (2015: 796), linear programming (LP) is a mathematical technique that is widely used to help operational managers plan and make the necessary decisions to allocate resources.

According to Paninduri and Syafwan (2019:6), a linear program translated from Linear Programming (LP) is a way to solve the problem of allocating limited resources among several competing activities, in the best possible way.

According to G.A. Silver, J.B. Silver in the program Haming et al (2019:26). linear in operational research is defined as a procedure for getting the maximum value or a linear function bounded by constraint function which is also linear. Further, ES. Buffa and Sarin stated that the linear program is the analysis model used for allocating limited or scarce resources to types of use that compete in such a way, in order to obtain a solution that is optimal (maximizing the cost contribution).

The linear programming model makes three main elements, namely: (1) Decision variables, which are problem variables that will affect the value of the goal to be achieved; (2) Objective function, which is the goal to be achieved that must be realized into a linear mathematical function; (3) Functional constraints, which are management facing various constraints to realize its goals.

2. Simplex Method
   According to Paninduri and Syafwan (2016:20) the simplex method is used for linear programming problems involving more than two variables, where the graphical method is used will experience difficulties. simplex method can also be used to solve problems with two variables. This method solves linear programming problems through computations that are repeated (iteration) where the same calculation steps are repeated many times before the optimal solution is reached. The simplex method can solve linear programming problems that have a large enough decision variable or more than two. There is According to Paninduri and Syafwan, there are several provisions that need to be considered (2016:20-21) in this simplex method.
   1) The right (NK/RHS) value of the objective function must be zero (0).
   2) The right value (RHS) of the constraint function must be positive. If negative, the value must be multiplied by -1.
   3) The constraint function with the sign "≤" must be changed to the form "=" with adding a slack/surplus variable. Slack/surplus variables are also called base variable.
   4) The constraint function with the sign "≥" is changed to the form "≤" by multiplying with -1, then changed to equation form by adding variables

slack. Then because the RHS is negative, multiply it again by -1 and plus artificial variable (M).

5) Constraint functions with an “=” sign must be added with an artificial variable (M).

According to Paninduri and Syafwan (2016:20) the simplex method used for linear programming problems involving more than two variables, where if the graphical method is used will experience difficulties. simplex method can also be used to solve problems with two variables. This method solves linear programming problems through computations that are repeatedly (iteration) where the same calculation steps are repeated many times before the optimum solution is reached.

The simplex method is a method that systematically starts from a basic solution that is fisible other, repeatedly so as to achieve an optimal basic solution (Rosita, 2019)The calculation process is carried out using the simplex method manually, here are the steps in applying the simplex method manually:

1) Determine the decision variables to be used and converted into a mathematical model.
2) Determining the objective function to be achieved and converted into a mathematical model.
3) Determine the constraint function obtained by converting it into a mathematical model function.
4) Compile the mathematical model equation into a simplex table and determine the key column and key row.

Table 1. Simplex Table

Variabel dasar	x1	x2	...	xn	S1	S2	...	Sn	NK
Z	-c1	-c2	...	-cn	0	0	0	0	0
S1	11	12	...	2n	1	0	0	0	b1
S2	21	22	...	2n	0	1	0	0	b2
⋮	...	...	...	...	...	...	...	...	...
Sn	m1	m1	...	...	...	...	...	1	bm

Description:
The base variable is the variable whose value is equal to the right-hand side of the equation.

Z is the objective function.
X1...Xn is the constraint function.
S1 ... Sn is a slack variable, which is a variable added to the mathematical model of the constraint function to convert the inequality into an equation.
NK is the key value of the equation, i.e. the value behind the sign is equal to the value of the available limiting resource.

1) Perform a key number (cell element) through the intersection between the key column and key row.

2) Perform stages (iterations) by changing the decision variable and dividing the value in the key by the key number.
3) Change the values outside the key row until there are no negative values.
4) If there is still a negative z coefficient then the iteration continues until the optimal result is obtained.

RESULTS

The data used in this study is data obtained from Mrs. Devi's 'Sohibkoe' business, the data results are presented in table 1. Based on the results of the interview, it is known that Mrs. Devi's business provides several menus, such as Sambal Cumi Petai and Sambal Teri. In a week the business uses cayenne pepper, shallots, anchovies, squid, and petai which are the main ingredients of the business, so it will produce 9 bottles of petai squid sauce and 6 bottles of anchovy sauce. Sambal Cumi Petai sells for Rp 28,000/bottle with a production cost of Rp 17,500/bottle and for the price of Sambal Teri Rp 25,000/bottle with a production cost of Rp 14,000/bottle. The profit for one production is presented in table 2

Table 2. Production Data of Chili Squid Petai and Chili Anchovy Sauce

Bahan	Sambal Cumi Petai	Sambal Teri	Persediaan
Cumi	30	-	240
Teri	-	55	385
Petai	25	-	200
Sambal	130	130	1950
Botol	8	7	

Table 3. The Production Profit of Chili Squid Petai and Chili Anchovy Sauce in One Production

	Sambal Cumi Petai	Sambal Teri
Harga Jual	Rp 224.000	Rp 175.000
Biaya Produksi	Rp 140.000	Rp 100.000
Keuntungan	Rp 84.000	Rp 75.000

To find out the optimal profit from the production of the two types of products above, this research can be solved using a linear program in the simplex method which consists of decision variables, objective functions, and constraint functions. Here are the steps to solve the problem (Dudy Effendy, 2022), which are:

Step 1. Determine the satisfaction variable
X = Production quantity of chili squid petai sauce
X2 = Total production of anchovy chili sauce

Step 2. Determine the objective function and convert it into a mathematical form
Zmax = 84.000X1 + 75.000X2 → maxZ - 84.000X1 – 75.000X2 = 0

Step 3. Determine the Constraint Function
Cumi : $30X1 \leq 240 \rightarrow 30X1 + S1 \leq 240$
Teri : $55X2 \leq 385 \rightarrow 55X2 + S2 \leq 385$
Petai : $25X1 \leq 200 \rightarrow 25X1 + S3 \leq 200$
Sambal : $130X1 + 130X2 \leq 1950 \rightarrow 130X1 + 130X2 + S4 \leq 1950$

Step 4. Determining the sign constraints
$X1 \geq 0$;
$X2 \geq 0$

Step 5. Putting the equation into a table

Table 4. Initial Simplex Table

NB	X1	X2	S1	S2	S3	S4	NK
Z	-85.000	-75.000	0	0	0	0	0
S1	30	0	1	0	0	0	240
S2	0	55	0	1	0	0	385
S3	25	0	0	0	1	0	200
S4	130	130	0	0	0	1	1950

Step 6. Determine the key column
The key column is determined from the objective function coefficient, which is the column with the largest negative coefficient that can be seen in the table.

Table 5. Columns

NB	X1	X2	S1	S2	S3	S4	NK
Z	-85.000	-75.000	0	0	0	0	0
S1	30	0	1	0	0	0	240
S2	0	55	0	1	0	0	385
S3	25	0	0	0	1	0	200
S4	130	130	0	0	0	1	1950

Step 7. Determining the key row
The key row is determined from the row that has the smallest index, the index is obtained from the right value (NK) divided by the key column value.

Table 6. Intersection Between Key Columns and Key Rows

NB	X1	X2	S1	S2	S3	S4	NK	Indeks
Z	-85.000	-75.000	0	0	0	0	0	0
S1	30	0	1	0	0	0	240	8
S2	0	55	0	1	0	0	385	0
S3	25	0	0	0	1	0	200	8
S4	130	130	0	0	0	1	1950	15

Step 8. Determining the new key row value
The new key row is obtained from the key row divided by the key number.

Table 7. New Key Lines

NB	X1	X2	S1	S2	S3	S4	NK	Indeks
Z								
S2								
S3								
S4								
X1	1	0	1/30	0	0	0	8	8

Step 9. Changing values other than the key row
The way to calculate the new row is new row = old row - (key column value x new key row value.

NB	X1	X2	S1	S2	S3	S4	NK
Z	-85000	-75.000	0	0	0	0	0
-85000	1	0	1/30	0	0	0	8
	0	-75.000	2833,4	0	0	0	680000

NB	X1	X2	S1	S2	S3	S4	NK
S3	25	0	0	0	1	0	200
25	1	0	1/30	0	0	0	8
	0	0	- 5/6	0	1	0	0

NB	X1	X2	S1	S2	S3	S4	NK
S4	130	130	0	0	0	1	1950
130	1	0	1/30	0	0	0	8
	0	130	-4 1/3	0	0	1	910

NB	X1	X2	S1	S2	S3	S4	NK
S2	0	55	0	1	0	0	385
0	1	0	1/30	0	0	0	8
	0	55	0	1	0	0	385

Step 10. Inserting key row values
The new row values that have been calculated are inserted into the table.

Table 8. Key Row Value

NB	X1	X2	S1	S2	S3	S4	NK
Z	0	-75.000	2833,4	0	0	0	680000
S2	0	55	0	1	0	0	385
S3	0	0	-5/6	0	1	0	0
S4	0	130	-4 1/3	0	0	1	910
X1	1	0	1/30	0	0	0	8

Step 11. Recalculate and determine the key column
Because there is still a negative value on Z, the calculation has to be done again to get a positive value.

Table 9. Row Column

NB	X1	X2	S1	S2	S3	S4	NK	Indeks
Z	0	-75.000	2833,4	0	0	0	680000	0
S2	0	55	0	1	0	0	385	7
S3	0	0	-5/6	0	1	0	0	0
S4	0	130	-4 1/3	0	0	1	910	7
X1	1	0	1/30	0	0	0	8	0

Step 12. Determining the key row

Table 10. Intersection Between Key Column and Key Row

NB	X1	X2	S1	S2	S3	S4	NK	Indeks
Z	0	-75.000	2833,4	0	0	0	680000	0
S2	0	55	0	1	0	0	385	7
S3	0	0	-5/6	0	1	0	0	0
S4	0	130	-4 1/3	0	0	1	910	7
X1	1	0	1/30	0	0	0	8	0

Step 13. Determining the new key row value

Table 11. New Key Line

NB	X1	X2	S1	S2	S3	S4	NK	Indeks
Z								
S3								
S4								
X1								
X2	0	1	1/55	0	0	0	7	

Step 14. Changing values other than the key row

NB	X1	X2	S1	S2	S3	S4	NK
Z	0	-75000	2833,4	0	0	0	680000
-75000	0	1	0	1/55	0	0	7
	0	0	2833,4	-1363,64	0	1	155000

NB	X1	X2	S1	S2	S3	S4	NK
S3	0	0	- 5/6	0	1	0	0
0	0	1	0	1/55	0	0	7
	0	0	- 5/6	0	1	0	0

NB	X1	X2	S1	S2	S3	S4	NK
S4	0	130	-4 1/3	0	0	1	910
130	0	1	0	1/55	0	0	7
	0	0	-4 1/3	130/55	0	1	0

NB	X1	X2	S1	S2	S3	S4	NK
X1	1	0	1/30	0	0	0	8
0	0	1	0	1/55	0	0	0
	1	0	1/30	0	0	0	8

Step 15. Entering the key row value

Table 12. Key Row Values

NB	X1	X2	S1	S2	S3	S4	NK	Indeks
Z	0	0	2833,4	-1363,64	0	1	155000	0
S3	0	0	- 5/6	0	1	0	0	0
S4	0	0	-4 1/3	130/55	0	1	0	0
X1	1	0	1/30	0	0	0	8	0
X2	0	1	1/55	0	0	0	7	0

Based on Table 12, the objective function coefficient is not negative, so the optimal result has been obtained, namely x1 = 8 and x2 = 7 obtained Zmax = 155,000. Where x1 states the amount of production, which are 8 bottles of Sambal cumi petai and x2 states the amount of production, which are 7 Sambal teri bottles, and Zmax states the maximum profit of Rp155,000.

DISCUSSION

The research aimed to optimize the profit of the Sambal SohibKoe business owned by Mrs. Devi, which operates in the culinary industry as a Micro, Small, and Medium Enterprise (UMKM) in Indonesia. The study focused on addressing the challenges faced by the business, such as pricing, limited availability of raw materials, and the impact of customer demand on profit. To achieve the goal of profit optimization, the researchers employed the linear programming simplex method.

Linear programming is a mathematical technique widely used in operational management to allocate resources and make informed decisions. The simplex method, a specific approach within linear programming, was applied in this research to solve the optimization problem. The method involves iteratively testing corner points to find the optimal solution. By applying the simplex method to the Sambal SohibKoe business, the researchers aimed to balance production factors and develop appropriate production plans to maximize profit.

The data for the study were obtained through direct interviews with Mrs. Devi, the owner of the Sambal SohibKoe business. Based on the linear programming simplex method, the research yielded optimal calculation results. It was found that the maximum weekly profit amounted to 155,000 Indonesian Rupiah (IDR) with a production quantity of 8 bottles of Sambal Cumi Petai and 7 bottles of Sambal Teri.

The research methodology employed both field studies and literature reviews. Interviews with Sambal sellers provided firsthand data, while literature studies supplemented the research materials with information from various articles. The study focused on optimizing profit through linear programming, with the simplex method serving as a tool for decision-making and contributing to the field of business and economics optimization.

The results of the study indicated that the application of linear programming with the simplex method can provide valuable insights for optimizing profit in small businesses like Sambal SohibKoe. By analyzing the data obtained from Mrs. Devi's business, the research identified the optimal production quantities for different types of chili sauce. This information can serve as a guide for managerial decision-making, enabling business owners to maximize profit by aligning production factors with market demand.

In conclusion, the researchers successfully demonstrated the implementation of the linear programming simplex method for profit optimization in the Sambal SohibKoe business. The study showcased the importance of strategic planning and decision-making in small businesses, particularly in the culinary sector. By using the simplex method, business owners can effectively allocate resources, determine optimal production quantities, and maximize profit. The findings contribute to the field of linear programming and optimization in the context of business and economics. Future research can further explore the application of linear programming in different types of businesses and industries, expanding the knowledge and understanding of optimization techniques for better decision-making.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis of field study data through interviews regarding the optimization of production of petai squid sauce and anchovy sauce on Mrs. Devi's Sohibkoe product, calculations are carried out using linear programming through the simplex method. By using this method, the results obtained for $x1 = 8$, $x2 = 7$ and $Zmax = 155{,}000$, which states that the maximum profit per week is 155,000 with the production of 8 bottles of petai squid sauce and 7 bottles of anchovy sauce. From this statement, it can be concluded that in this case, the simplex method can be a reference for managerial decision making. The results of the study can be used as a reference for managerial decision-making. Therefore, the implementation of the research results could be in the form of optimizing production and maximizing profits for small businesses in the culinary industry, particularly in the production of chili sauce.

FURTHER STUDY

While this research has provided valuable insights into UMKM, especially into the profit optimization using linear programming simplex method of culinary business, it is important to acknowledge that no study is without limitations. These limitations offer opportunities for further investigation and exploration, which can contribute to advancing knowledge in this field. In this section, we discuss the limitations of our study and provide suggestions for future research. One of the limitations of this study is the sample size. The relatively small size may restrict the generalizability of our findings. Future studies could aim to include larger and more diverse samples to enhance the external validity of the results.

Furthermore, the present study focused on a specific aspect of profit optimization. Future research could explore additional variables or factors that may influence the outcomes. For example, investigating the role of cultural or contextual factors could provide a more nuanced understanding of the phenomenon and its impact. Moreover, our study predominantly focused on quantitative measures. Incorporating qualitative approaches, such as interviews or focus groups, could provide richer insights into the experiences, perspectives, and underlying motivations of the participants. This qualitative data could complement and further illuminate the quantitative findings.

In conclusion, while this study has provided valuable contributions to understanding profit optimization using the linear programming simplex method, it is essential to acknowledge its limitations. Future research should address these limitations by incorporating larger samples, employing diverse methodologies, exploring additional variables, utilizing longitudinal designs, and considering qualitative approaches. By addressing these areas of further study, we can deepen our understanding and contribute to the advancement of knowledge in this field.

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