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APPLICATION OF THE SIMPLEX METHOD AND DIGITAL LITERACY IN PROFIT OPTIMIZATION PROBLEMS TAUFIK TEMPE

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ABSTRACT
Resource allocation in the production process are important things that need to be considered to achieve optimal production levels. Production optimization problems are still an obstacle for most businesses operating in the food sector. One of them is the "Taufik Tempe" business which produces tempeh in three different sizes, namely large, medium, and small. The business owner finds it difficult to determine the amount of production according to market demand and minimize production costs for maximum profits. This research aims to solve the profit optimization problem of "Taufik Tempe" with appropriate production allocation to achieve maximum profits. The method used is the method of data collection and data analysis. Data collection methods include field studies (observations and interviews) and literature review. Meanwhile, data analysis uses the simplex method and uses MATLAB software. Data analysis techniques using observation and interviews. Meanwhile, the research results show that the maximum profit per month obtained is Rp 750.000,00 by focusing on producing only large-sized tempeh. Furthermore, by using MATLAB software the same results are obtained as using the simplex method but with a simple, effective and efficient algorithm, ofcourse with precise results and the use of this software aims to avoid calculation errors.
Keywords: Simplex Method, MATLAB Software, Profit Optimization Problems

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PRELIMINARY

Tempeh is a typical Indonesia food that is widely consumed by people Indonesia people and abroad. Tempe is not only popular in Indonesia but also abroad. In 2021, Indonesia has exported 13,8 tons of tempeh to Japan (Sugianto, 2021). Based on the high demand for tempe consumption in Indonesia and abroad, many people are interested in starting a business for producing tempeh.

In Indonesia, there are many tempeh factories to produce tempeh. Specifically, there are many tempe factories in Situbondo, one of which is the "Taufik Tempe". This

factory produces tempeh every day in several sizes of tempeh different sizes, namely large, medium and small. This happens because of market demand and consumers around the factory. However, every business has its own obstacles. Meanwhile, the problems faces by the "Taufik Tempe" business are determining the production quantity for each size of tempe. Often occur accumulation of certain sizes of tempeh, while other sizes of tempeh are sold out, so causing losses to the "Taufik Tempe" business. Meanwhile, resources is an important component to produce large quantities of finished products. So, it is necessary to utilize appropriate resources to achieve maximum profits maximum (Anti & Sudrajat, 2021; Hidayah et al., 2022; Nurhidayah & Mas'ud, 2023; Tae et al., 2023). Meanwhile, the main objective is business activities is to obtain maximum profits with minimal resource costs (Purba & Ahyaningsih, 2020).

This problem is an example of an optimization problem and can be solved using methods in linear programming. According to Hani & Harahap (2021) and Tamiza et al., (2023), optimization is a collection of mathematical formulas and numerical methods for find and identify the best candidate from a set of alternatives without having to explicitly calculate and evaluate all possible alternatives. Lots ways that can be done to solve problems to provide the best results. Optimization problems can be solved using Integer Linear Programming (ILP), because the results obtained integers and not fractional form. There are several methods of integer linear programming, however in determining the solution to optimization problems, the integer linear programming method used together with the simplex method. If the results of the simplex method fraction or not and integer, then the next step the results will be processed using methods from integer linear programming.

Linear programming is a mathematical method for achieving a single goal, for example maximizing profits or minimizing costs. As for chraracteristics problem in linear programming, namely: (1) There is a goal to be achieved, (2) Has several alternatives to obtain justification, (3) Limited resources, and (4) Can be written in mathematical form (Sitopu et al., 2023).

There are three important elements in linear programming (Rumetna et al., 2019), namely: 1) Decision variables ($x_1, x_2, \dots, x_n$) is a variable whose values the value is selected for a decision to be made; 2) Objective function ($Z = f(x_1, x_2, \dots, x_n)$) is the function to be optimized (maximized or minimized); dan 3) Constraints ($g_i(x_1, x_2, \dots, x_n) \leq b_i$), is restrictions that must be met.

The method that can be used in linear programming is the graphical method (for 2 variable) and simplex method (for more than 2 variables). General graphic methods used to solve dimensional linear programming problems $2 \times n$ or $m \times 2$, because the ability of a graph to display calculation results is limited (Asmara et al, 2019).

Meanwhile, the simplex method is a method that starts systematically from one feasible basic solver to another possible basic solver, done sequentially iteratively so that finally an optimal and basic solution is reached for each step produces a value from the objective function that is always greater than or equal to previous steps (Aprilyanti et al., 2018; Jamal & Sari, 2022). The advantage of the simplex method is that it can calculate two or more decision variables when compared using graphical methods which is only able to apply two decision variables (Asmara et al, 2019).

However, the application of the simplex method to daily problems is possible troublesome because of the many stages and components of the simplex method that must be carried out done. As with the algebraic method, before doing the initial solution, first you have to standardize the model formulation. Constraint functions is still in the form of an inequality, it must first be converted into an equation with preceded by Gaussian elimination (Rois, 2018). One alternative that can be done to solve the problem optimization using a simple but simple method, namely digital literacy or using technology or digital media. One of the media or software that can used and often used in mathematics learning is MATLAB software.

MATLAB was originally only used for numerical analysis, linear algebra, and matrix. However, currently MATLAB's capabilities and features have gone far more complete with the addition of various toolboxes. MATLAB, which is a high-level programming language based on matrices is often used for numerical computing techniques, which are used to solve problems involving mathematical operations of elements, matrices, optimization, approximation, etc. So MATLAB is widely used in: 1) Mathematics and Computing, 2) Development and Algorithms, 3) Programming Modeling, Simulation and Prototyping, 4) Data Analysis, Exploration and Visualization, 5) Numerical and Statistical Analysis, and 6) Application Development Technique (Busrah, 2019).

MATLAB is a programming software for calculation, analysis, simulation, prototyping and visualization are widely used in all areas of mathematical application both in the fields of education and research at universities and industry, in particular about engineering and engineering (Setiawan & Sastro, 2019). By using MATLAB, then complex mathematical calculations can be implemented in programs more easy.

Algorithms in MATLAB can solve almost all mathematics problems, including optimization problems. Optimization problems can be solved with an algorithm in MATLAB, but many people does not know to use MATLAB software to solve optimization problems. Most people use another software such as Linggo to solve optimization problems (Azzahrha et al., 2021; Supatimah et al., 2019; Suwirmayanti, 2018).

Furthermore, previous research obtained the following results that is, the A* (Star) algorithm can be used to minimize distances or route as well as saving costs incurred by the company (Ropiqoh, & Lubis, 2023). Next, Andarayani & Sari, (2022), Handayani et al., (2022), and Litano & Suhendar, (2020) explain about obtained profit results optimal and combined production by applying one of the algorithms from integer linear programming. Meanwhile, another research (Nurmayanti & Sudrajat, 2021) was conducted to analyze the implementation of linear programming by using the simplex method manually in the home industry to obtain maximum profit with optimum production quantity. Whereas, MATLAB software has been used to support mathematics learning, for example, it can be used to support online learning (Lusiana & Styansah, 2021) and improve student learning outcomes (Apriansyah & Baysha, 2018). Apart from MATLAB software, there are another software that often used or is closely used to solve problems optimization problems, namely Lingo optimization software, researchers also often implement research related to the use of Lingo optimization software, as carried out by Puspita et al., (2021) and Ayunda et al., (2021). Next, in another research (Clacier et al., 2023; Dali et al., 2022; Ghaliyah et al., 2021; Madelu et al., 2024; Rusdiana & Istiono, 2023; Sari et al., 2020; Sitorus et al., 2019), research was carried out with the aim of minimizing production costc and maximizing income/profits using various linear programming methods with the help of various software, such as POM-QM, LINDO and other software. Meanwhile, Hussain et al., (2019) explains in detail the stages of the simplex method for solve optimization problems. Furthermore, Astutik & Fitriatien (2019) researched about the effect of using MATLAB software on the ability to complete linear programming problems and obtained students feel happy, easy to understand and be able to use the software to solve their linear programming problems. Based on the problems, this research was carried out to solving optimization problems in “Taufik Tempe” using the simplex method and algorithm compiled in MATLAB software.

METHODS

This section will explain the research steps carried out in the field. This research was conducted at the "Taufik Tempe", Situbondo. The research object is tempeh with three different sizes, namely large, medium, and small. The steps to determine the profit optimization of the "Taufik Tempe" can be seen in Figure 1 below:

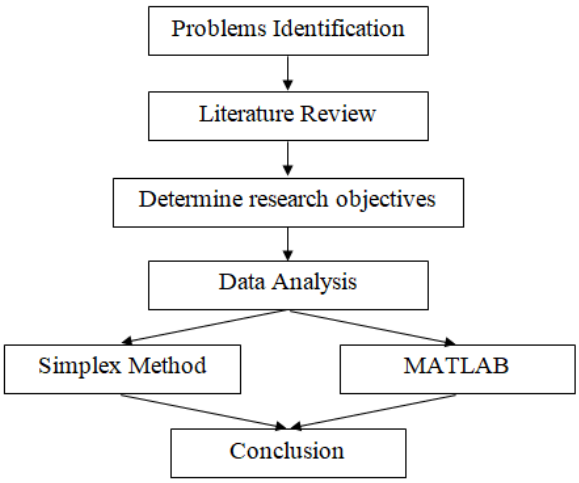

Figure 1. Research Flowchart

The following is a detailed explanation of the research flowchart:

1. **Data Collection Method**

   The first step of this research was collecting data. The aim is to analyzing production conditions at the "Taufik Tempe" and problems experienced that can be solved with a linear programming. Here are some data collection methods used in this research:

   a) Field Study

      The field study carried out by observation and interviews with the owner of "Taufi Tempe" business. The information obtained about production costs incurred, tempeh sales, and profits obtained from the sale of tempeh

   b) Literature Review

      The aim of this literature review is to finding references that related to solved optimization problems and linear programming methods used to solve optimization problems. This literature review was carried out by reviewing articles and books related to optimization problems solved by linear programming methods.

2. Data Analysis Method

The data analysis method used in this research is linear programming methods, namely, the simplex method and MATLAB software. The advantage of the simplex method is that it can calculate two or more decision variables when compared using graphical methods which is only able to apply two decision variables (Asmara et al., 2019). The steps to solving problems using the simplex method are described in detail in Aini et al., (2021), Kustiawati et al., (2022), Dharmawan & Arifin, (2022), Lestari et al., (2023), Susanti, (2021). Furthermore, this research was carried out with detailed steps as follows:

a) Formulate daily problems in the form of mathematical models, in this case in the form of a linear programming optimization problem;
b) Solving linear programming optimization problems using the simplex method;
c) Analyze the result of calculations by using the simplex method, whether the results are an integers or not;
d) If the solution is an integer, then the solution is the optimal solution. Meanwhile, if the solution is not an integer, then the next steps we must to do is solving by using the integer linear programming method;
e) Solving linear programming optimization problems with MATLAB software;
f) Comparative analysis of solving linear programming optimization problems using the simplex method and MATLAB software;
g) Concluding the results of the research.

RESULT AND DISCUSSION

Based on the results of observations and interviews, it is known that the “Taufik Tempe” produces tempeh every day in three different sizes, namely large, medium, and small. Every day “Taufik Tempe” processes 2,5 quintals of soybeans into tempeh. Apart from soybeans, there are another production raw materials used as a consideration for determining the selling price of tempeh. Market demand of tempeh is different every day and sometimes there is some tempeh left with of a certain size. Furthermore, several times the size of tempeh that the costumer expected has run out but the customer doesn’t want to buy tempeh of a different size. Thus, analysis of production is required for three different sizes so the production of “Taufik Tempe” can reach the maximum and the profits obtained

are also maximum. In order to solving the optimization problem of this research, we used 2 method, that is using the simplex method and MATLAB software. The data obtained from interviews with the owner of the "Taufik Tempe" regarding the raw materials for tempeh production can be seen in this Table 1.

Table 1. Data on The Need and Availability of Raw Materials for Making Tempe of "Taufik Tempe"

No.	Constraint	Large Size of Tempeh	Medium Size of Tempeh	Small Size of Tempeh	Availability
1.	Soybeans	0,27 kg	0,135 kg	0,11 kg	7.500 kg
2.	Plastics	0,13 m^2	0,22 m^2	2,75 m^2	120.000 m^2
3.	Oil	5 liter	2 liter	1 liter	1.200 liter
4.	Token	6.000	3.000	2.000	750.000
5.	Employee Salary	2.000	1.000	500	6.000.000
6.	Production Capacity	1 pack	1 pack	1 pack	150 pack

1) Solving Optimization Problems Using the Simplex Method

The stages in the simplex method calculation, that is:

1. Determine variables

   X_1 = Large size of tempeh

   X_2 = Medium size of tempeh

   X_3 = Small size of tempeh

2. Objective Function

   $Z = 2.000\ X_1 + 2.500\ X_2 + 5.000\ X_3$

3. Constraints

   $0{,}27\ X_1 + 0{,}135\ X_2 + 0{,}11\ X_3 \leq 7.500$

   $0{,}13\ X_1 + 0{,}22\ X_2 + 2{,}75\ X_3 \leq 120.000$

   $5\ X_1 + 2\ X_2 + X_3 \leq 1.200$

   $6.000\ X_1 + 3.000\ X_2 + 2.000\ X_3 \leq 750.000$

   $2.000\ X_1 + 1.000\ X_2 + 500\ X_3 \leq 6.000.000$

   $X_1 + X_2 + X_3 \leq 150$

4. Standard Form or Objective Function

   $Z = 2.000\ X_1 + 2.500\ X_2 + 5.000\ X_3 + 0.X_4 + 0.X_5 + 0.X_6 + 0.X_7 + 0.X_8 + 0.X_9$

5. Standard Form of Constraints

   $0{,}27\ X_1 + 0{,}135\ X_2 + 0{,}11\ X_3 + X_4 \leq 7.500$

   $0{,}13\ X_1 + 0{,}22\ X_2 + 2{,}75\ X_3 + X_5 \leq 120.000$

   $5\ X_1 + 2\ X_2 + X_3 + X_6 \leq 1.200$

$6.000\ X_1 + 3.000\ X_2 + 2.000\ X_3 + X_7 \leq 750.000$

$2.000\ X_1 + 1.000\ X_2 + 500\ X_3 + X_8 \leq 6.000.000$

$X_1 + X_2 + X_3 + X_9 \leq 150$

$X_1, X_2, X_3 \geq 0$ (*integer*)

6. Insert coefficient of constraints and objective function in the Simplex Table.

Table 2. Simplex Table

	c_j	**2000**	**2500**	**5000**	**0**	**0**	**0**	**0**	**0**	**0**		
$\hat{c}_i$	$\overline{x_i}/x_j$	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	b_i	R_i
0	x_4	270	135	110	1000	0	0	0	0	0	7.500.000	
0	x_5	13	22	275	0	100	0	0	0	0	12.000.000	
0	x_6	5	2	1	0	0	1	0	0	0	1.200	
0	x_7	6000	3000	2000	0	0	0	1	0	0	750.000	
0	x_8	2000	1000	500	0	0	0	0	1	0	6.000.000	
0	x_9	1	1	1	0	0	0	0	0	1	150	
	z_j	0	0	0	0	0	0	0	0	0	Z = 0	
	$z_j - c_j$	-2000	-2500	-5000	0	0	0	0	0	0	Z = 0	

In the Table 2, it is known that the constraints are not optimal because there is a value of $z_j - c_j \leq 0$, so the simplex method iteration must be carried out.

7. Iteration 1

Table 2. Iteration 1

	c_j	**2000**	**2500**	**5000**	**0**	**0**	**0**	**0**	**0**	**0**		
$\hat{c}_2$	$\overline{x_i}/x_j$	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	b_i	R_i
0	x_4	270	135	110	1000	0	0	0	0	0	7.500.000	68.181,82
0	x_5	13	22	275	0	100	0	0	0	0	12.000.000	43.636,36
0	x_6	5	2	1	0	0	1	0	0	0	1.200	1.200
0	x_7	6000	3000	2000	0	0	0	1	0	0	750.000	375
0	x_8	2000	1000	500	0	0	0	0	1	0	6.000.000	12.000
0	x_9	1	1	1	0	0	0	0	0	1	150	150
	z_j	0	0	0	0	0	0	0	0	0	Z = 0	
	$z_j - c_j$	-2000	-2500	-5000	0	0	0	0	0	0	Z = 0	

Next, select the smallest value of $z_j - c_j$ to determine the key column, then we get column x_3 as the key column. Then, determine the value of R_i. Select the smallest value of R_i to determine the key row. In this way, we get the key number is 1. In Iteration 1, we get the entry variable is x_3 and the exit variable is x_9. Then continue with Iteration 2.

8. Iteration 2

Table 3. Iteration 2

	c_j	**2000**	**2500**	**5000**	**0**	**0**	**0**	**0**	**0**	**0**		
$\hat{c}_2$	$\overline{x_i}/x_j$	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	b_i	R_i
0	x_4	160	25	0	1000	0	0	0	0	-110	7.483.500	
0	x_5	-262	-253	0	0	100	0	0	0	-275	11.958.750	
0	x_6	4	1	0	0	0	1	0	0	-1	1.050	
0	x_7	4000	1000	0	0	0	0	1	0	-2000	450.000	
0	x_8	1500	500	0	0	0	0	0	1	-500	5.925.000	
5000	x_3	1	1	1	0	0	0	0	0	1	150	
	z_j	5000	5000	5000	0	0	0	0	0	5000	**Z = 750.000**	
	$z_j - c_j$	3000	2500	0	0	0	0	0	0	5000	**Z = 750.000**	

In Table 3, Iteration 2 is shown, where all of the value is $z_j - c_j \geq 0$. So optimum results are obtained from solving optimization using the method simplex. Iteration 2 shows the final result of the simplex method with a value of Z = 750.000.

Calculation results using the simplex method shows that the profit obtained Rp 750.000,00 per month by only focusing on producing large size of tempeh as many as 150. In this research, the optimal solution to the decision variable hoped that it will be an integer and because the solution is an integer then the solution is the optimal solution.

2) Solving Optimization Problems with MATLAB Software

Solving optimization problems other than being solved using simplex method or manually, also completed using MATLAB software. There are many benefits from using technology in daily life by society, some of the benefits of using technology or digital literacy is efficient, obtain information quickly, learn faster, and enrich skills. Therefore, in this research the optimization problem solved by utilizing technology, in this case that is MATLAB software.

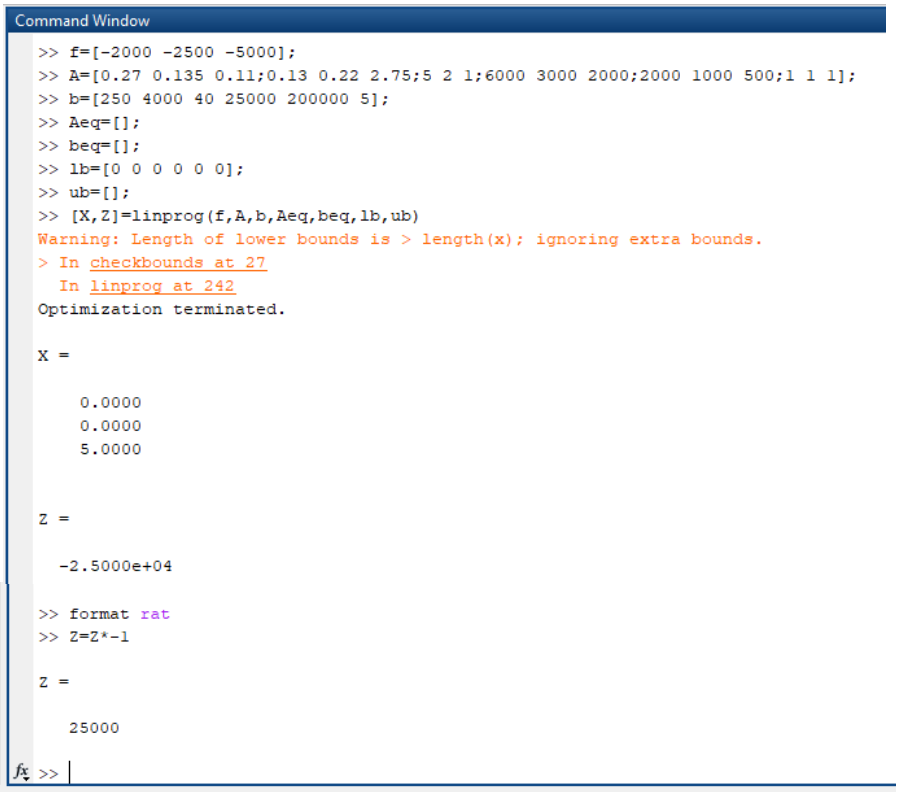

Figure 2. Results of Solving Optimization Problems using MATLAB Software

Based on the results of solving optimization problems using MATLAB software, the same result obtained and is an integer, that is, Z = 750.000.

CONCLUSION

Problems that arise at the "Taufik Tempe" business can be solved using methods in linear programming. One effective method to use is the simplex method. Furthermore, calculations were also solved using MATLAB software to compare calculation results using simplex method and avoid errors in calculation. Based in the results of solving linear programming optimization problems with these two methods, the same results are obtained, namely maximum profits can be obtained in a month is Rp 750.000,00 by just focusing on producing large size tempeh. Based on these results, the benefits obtained by "Taufik Tempe" are information on producing only small sizes of tempeh, so "Taufik Tempe" can obtain maximum profits every day.

Furthermore, consider the work process on solving the linear programming optimization problems using the simplex method and MATLAB software. Solving the problem using the simplex method requires more time to calculate, whereas by using MATLAB software it only takes a shorter time to know the results. However, even using

MATLAB software takes less time, but it takes effort to understand MATLAB software programming language for linear programming optimization problems. So, using MATLAB software is truly effective and efficient, but it requires effort to understand it first.

Furthermore, opportunities that can be carried out in further research include analyzing optimization problems that occur in different business fields, not only in the food business. Further research can also be carried out on businesses on a larger and broader scale or in other words paying attention to production factors that are more diverse and more real. So that more significant and influential results can be obtained for the business.

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