Utilization of linear programming in optimizing profits of Burger Trader Streets in Medan City, Indonesia

Suvriadi Panggabean[1,*], Lasker P. Sinaga[1], Zainal Azis[2], Tua Halomoan Harahap[2]

[1]Department of Mathematic, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan, Sumatera Utara, Indonesia

[2]Department of Mathematic Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Sumatera Utara, Sumatera Utara, Indonesia

*Email: suvriadi@unimed.ac.id

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Abstract *Linear programming is one of the mathematical methods that can be used in determining the allocation of a limited resource to achieve a certain goal. The purpose of this research is to optimize the revenue gain from selling burgers by determining the maximum number of sales of each available variant. This research is quantitative research conducted by interview method. The research subject used was one of the street burger vendors in the city of Medan. The objects in this study were 3 types of burger variants, namely meat + egg burger, egg + nugget burger, and 2 meat + egg + nuggets burgers. Based on the results of linear programming analysis of the number of sales of each burger variant, the maximum profit formula is $Z = 8x_1 + 10x_2 + 12x_3$. In order to obtain optimal profit, the seller must be able to sell 20 portions of meat + egg burgers (x_1), 5 portions of egg + nugget burgers (x_2), and 5 portions of 2 meat + egg + nuggets (x_3). Thus, the maximum profit or optimal profit obtained is 270K.* [UTILIZATION OF LINEAR PROGRAMMING IN OPTIMIZING PROFITS OF BURGER TRADER STREETS IN MEDAN CITY, INDONESIA] ***(J. Math. Nat. Sci., 2(2): 7 - 11 2022)***

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Introduction

Burger is one of the foods that are in great demand by the public, especially among young people. Burger is a fast food that is much liked by the general public, because it is delicious, and tasty, and makes you feel full because it contains fat and protein (Sembor et al., 2022). Burgers which are also included in the Junkfood category consist of several variants of fillings ranging from meat burgers, eggs, nuggets, sausages, cheese, and other fillings to even combinations of these ingredients. This food is still said to be unhealthy even though it contains vegetables, bread, and meat. However, this does not reduce the interest in this food. The main ingredients for making burgers include bread, vegetables, stuffing (meat, eggs, nuggets, sausages, cheese, shredded, and others), mayonnaise, chili sauce, cucumber, and tomatoes.

Limited availability of stuffing or resources used for making burgers is a problem that has an impact on the income/profit gained by traders. To effectively and efficiently solve the problem of the allocation of limited resources to get optimal benefits, it is not enough just to apply personal experience, intuition, or guesswork. This is because every decision taken will have an impact on the benefits obtained. Profit optimization is a goal that every trader wants to achieve. Several ways can be done so that profit optimization can be obtained. Utilization of limited resources to the fullest extent possible is intended to achieve results following production targets (Oktarini, 2013).

The obstacle that is often experienced by managers in a company is maximizing profits by considering how much of each product the company will produce (Abriani et al., 2020). This is because basically, the purpose of a company is to seek profit or profit or profit. The process of minimizing expenses in a company to obtain maximum profits is referred to as profit optimization activities (Anti and Sudrajat, 2021). The linear programming with the simplex method is a profit optimization principle that can be used to predict production costs and maximize profits (Oladejo et al., 2019).

Linear programming is a solution that is often used to solve problems with optimization (Ghaliyah et al., 2022). In solving the profit optimization problem referred to by the researcher using the simplex method which is done manually and then matched with the calculation results obtained in the QM For Windows application. The use of the simplex method to solve the problem of allocating available resources can solve linear programming of two or more variables (Aprilyanti et al., 2018). In this paper, we will discuss how to use linear programming in optimizing profits for street burger sellers in Medan City.

Materials and Methods

Linear programming is a mathematical model for obtaining the best alternative use of available resources (Asmara et al., 2018). Linear programming is an Operating Research technique that is most widely used and easy to understand (Mulyono, 2004). Linear programming states the use of certain mathematical techniques to obtain the best possibility for problems involving limited resources (Sriwidadi and Agustina, 2013). In building a model from a linear programming problem, the characteristics used are as follows: (1) Decision variables, (2) Objective functions, (3) Constraints, and (4) Sign boundaries (Nature et al., 2021).

The linear program consists of 3 important elements (characteristics), namely the decision variable, the objective function, and the constraint function. Decision variables are each of the elements in the problem that are influenced by decision making, described in full and will affect the objective function to be achieved. The objective function in linear programming is a function of the decision variable that will be maximized (generally revenue or profit/profit) or minimized (generally costs/costs or working time). Meanwhile, the constraint function is a function that limits the extent to which targets can be achieved or the availability of resources. In building a model from a linear programming problem, the characteristics used are as follows: (1) Decision variables, (2) Objective functions, (3) Constraints, and (4) Sign boundaries (Alam et al., 2021).

The simplex method is one of the methods used in solving simple linear programs. The simplex method is an algorithmic technique that calculates and stores large numbers of numbers in iterations that are taken into consideration for decision-making (Sriwadadi and Agustina, 2013). This research is quantitative. The data obtained in this study were sourced from the results of interviews with informants who were the subjects of the study, namely street vendors in Jalan Pancing, Medan City, in August 2022 and the objects in this study were 3 types of burger variants, namely meat + egg burger, egg + nuggets burger and 2 meat + egg + nuggets burger.

The stages carried out in this research are: (1) Conduct a literature study by studying various theories related to research conducted through several relevant books and journals; (2). Conduct direct observations in the field to obtain the data needed in the research; (3). Identify and formulate problems encountered in the results of observations made; (4). Collecting data and conducting data adequacy tests. The data that was successfully collected included the variety of burgers sold, the price per portion, and data on the capacity of the ingredients provided by the seller every day; (5). Perform data processing using the simplex method; (7). Optimizing merchant profits by setting the maximum number of sales of each burger variant to obtain optimal profits; (8). Analyze the suitability of the results obtained manually and the results in the QM For Windows application, and (9). Draw conclusions based on the research results obtained.

Results

Based on the results of the interviews conducted by the researchers, it was found that the research subjects, namely street burger vendors, sold 3 variants of burgers at different prices. The variants being sold are burgers with meat + egg fillings, egg + nuggets burgers, and 2 meat + egg + nuggets burgers. The meat + egg burger is sold at 8K/portion, the egg + nugget burger is sold at 10K/portion, while the 2 meat + egg + nuggets burgers are sold at 12K/portion. Every day, traders only provide a stock of 30 pieces of meat, 1 egg board, and 10 pieces of nuggets. In making burgers that use eggs it takes 1 egg per portion.

From the data that has been obtained above, it can be analyzed and calculated using the simplex method as follows:

x_1= number of variants of meat + burgers egg (BDT)

x_2 = number of egg + burger variants nuggets (BTN)

x_3 = number of 2 meat + burger variants egg + nuggets (B2DTN)

Table 1. Price variant Burger per portion

Burger Variant	Price/portions (K)
BDT (x_1)	8
BTN (x_2)	10
B2DTN (x_3)	12

Based on Table 1. above, an objective function can be formed where for example Z is the profit earned from selling burgers per day. So that, max $Z = 8x_1 + 10x_2 + 12x_3$.

Please note that meat is not used in the second variant x_2 while nuggets are not used in the first variant x_1. Meanwhile, the eggs are used by the three burger variants sold.

Table 2. The relationship between Burger variants and the stuffing ingredients used

Ingredients	Burger Variant			Stock
	x_1	x_2	x_3	
Meat	1	0	2	30
Egg	1	1	1	30
Nugget	0	1	1	10

So that the constraint function that can be formed based on the data obtained is:

$x_1 + 2x_3 \leq 30$

$x_1 + x_2 + x_3 \leq 30$

$x_2 + x_3 \leq 10$

$x_1, x_2, x_3 \geq 0$

And canonical form:

$Z = 8x_1 + 10x_2 + 12x_3 + 0S_1 + 0S_2 + 0S_3$

$Z - 8x_1 - 10x_2 - 12x_3 - 0S_1 - 0S_2 - 0S_3 = 0$....0)

$x_1 + 2x_3 + S_1 = 30$ ....1)

$x_1 + x_2 + x_3 + S_2 = 30$ ....2)

$x_2 + x_3 + S_3 = 10$ ....3)

Basic	Z	x_1	x_2	x_3	S_1	S_2	S_3	Rhs	Ratio
Z	1	-8	-10	-12	0	0	0	0	
S_1	0	1	0	2	1	0	0	30	30/2=15
S_2	0	1	1	1	0	1	0	30	30/1=30
S_3	0	0	1	1	0	0	1	10	10/1=10

Figure 1. Tablo I.

In Figure 1. it is known that the key column of tablo I is column x_3, namely the column with the most negative or smallest Z value. While the key row obtained from the lowest value of the comparison (ratio) between the value in the Rhs column and the value in the x_3 column is the 3rd row, namely row S_3. Thus, the key element is obtained, namely 1.

Basic	Z	x_1	x_2	x_3	S_1	S_2	S_3	Rhs	Ratio
Z	1	-8	2	0	0	0	12	120	
S_1	0	1	-2	0	1	0	-2	10	10/1=10
S_2	0	1	0	0	0	1	-1	20	20/1=20
x_3	0	0	1	1	0	0	1	10	-

Figure 2. Tablo II.

The values contained in tablo II in Figure 2 are obtained from the results of elementary row operations (OBE) I in the previous tablo I. The key column is in column x_1 and the key row is in row S_1. So that the key elements obtained are 1.

Basic	Z	x_1	x_2	x_3	S_1	S_2	S_3	Rhs	Ratio
Z	1	0	-14	0	8	0	-4	200	
x_1	0	1	-2	0	1	0	-2	10	-
S_2	0	0	2	0	-1	1	1	10	10/2=5
x_3	0	0	1	1	0	0	1	10	10/1=10

Figure 3. Tablo III.

In Figure 3, tablo III is presented, the values of which are the results of elementary row operations (OBE) II. Based on tablo III, it is known that the key column is in column x_2 and the key row is in row x_2. Thus, the key element obtained in tablo III is 2.

Basic	Z	x_1	x_2	x_3	S_1	S_2	S_3	Rhs
Z	1	0	0	0	1	7	3	270
x_1	0	1	0	0	0	1	-1	20
x_2	0	0	1	0	- ½	½	½	5
x_3	0	0	0	1	½	- ½	½	5

Figure 4. Tablo IV.

Tablo IV in Figure 4. is the optimal tablo because it does not contain negative values in row Z, which means that all Z values are positive. So, from table IV it can be seen that the max. Z is 270K. Meanwhile, the number of each burger variation, namely meat + egg burger, egg + nugget burger, and 2 meat + egg + nuggets burger which must be sold sequentially, is 20 servings, 5 servings, and 5 servings.

The objective function of the problem is : max. $Z = 8x_1 + 10x_2 + 12x_3$. It is known that the values of x_1, x_2, and x_3 are 20, 5, and 5 respectively. So if you substitute them into the equation, the max. Z is obtained:

$$Z = 8x_1 + 10x_2 + 12x_3$$

$$Z = 8(20) + 10(5) + 12(5)$$

$$Z = 160 + 50 + 70$$

$$Z = 270 \text{ (Proven)}$$

Thus, the results are the same as the Z value in Tablo IV, which is 270.

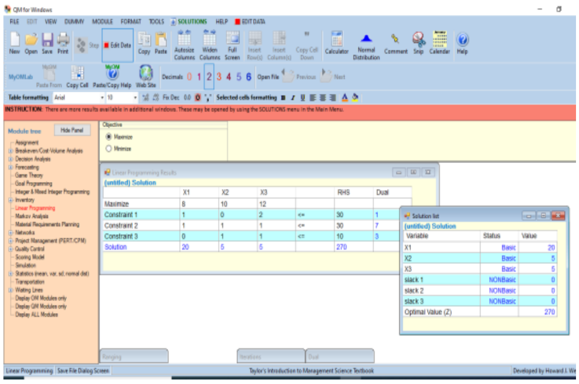

Figure 5. Calculations with QM for Windows.

In Figure 5. it can be seen that the calculations were carried out using the QM For Windows application or software. The results obtained from the application are the same as the results of manual calculations that have been done before. Thus, a match was obtained from the two methods used.

Conclusion

Based on the results of the study, it was found that the burger variants sold by traders consisted of 3 variants, namely meat + egg burger, egg + nugget burger, and 2 meat + egg + nuggets burgers. Where the price per portion of each burger variant is 8K, 10K, and 12K respectively. The obstacle that arises in this profit optimization problem is the stock or filling capacity provided by traders every day. Thus, based on the results of analysis and calculations using the simplex method of linear programming to optimize the profits of street vendors, it is found that the number of each burger variant that must be sold to obtain maximum profit sequentially is 20 portions, 5 portions, and 5 portions. The maximum or optimal profit obtained is 270K per day. The same results are also obtained by performing calculations with the help of an application or Software QM For Windows.

References

Abriani, D., Utami, P., Fausayana, I., Indarsyih, Y. (2020). Optimasi keuntungan usaha pengolahan biji Mete di Kota Kendari. *JIA: J. Agr. Ilm. Sos. Eko. Pert.*, 5: 65-68

Alam, T.B., Megasari, A., Ernawati, Amalia, S.A., aulani, N.G., Mahuda, I. (2021). Optimalisasi keuntungan produksi makanan menggunakan pemrograman linear melalui Metode Simpleks. available at: http://bayesian.lppmbinabangsa.id/index.php/home

Anti, A.R., Sudrajat, A. (2021). Optimasi keuntungan menggunakan linear programming Metode Simpleks. *J. Man.*, 13: 188-194

Aprilyanti, S., Pratiwi, I., Basuki, M. (2018). Optimasi keuntungan produksi kemplang panggang menggunakan linear programming melalui Metode Simpleks. *Seminar dan Konferensi Nasional IDEC*

Asmara, T., Rahmawati, M., Aprilla, M., Harahap, E., Darmawan, D. (2018). Strategi pembelajaran pemrograman linier menggunakan Metode Grafik dan Simpleks. *J. Tek. Pembel. Sek. Pascasarj. IPI Garut*, 3: 506-514

Ghaliyah, S.F., Harahap, E., Badruzzaman, F.H. (2022). Optimalisasi keuntungan produksi sambal menggunakan Metode Simpleks berbantuan Software QM. *Bandung Conf. Ser.: Math.*, 2: 9-16

Mulyono, S. (2004). Riset operasi. Jakarta: Penerbitan Fakultas Ekonomi Universitas Indonesia

Oktarini, D. (2013). Perencanaan produksi dalam usaha pencapaian target. *J. Desimin. Tek.*, 1: 145-152

Oladejo, N.K., Abolarinwa, A., Salawu, S.O., Lukman, A.F., Bukari, H.I. (2019). Optimization principle and its' application in optimizing landmark University Bakery production using linear programming. *Int. J. Civ. Eng. Tech.*, 10: 183-190

Sembor, S.M., Tinumbia, N.S.N., Kalele, J.A.D., Ponto, J.H.W., Hadju, R. (2022). Kualitas Burger Daging Itik dengan penambahan Ubi Jalar (*Ipomoea batatas L*). *Zootec*, 42: 367-376

Sriwidadi, T. Agustina, E. (2013). Analisis optimalisasi produksi dengan linear programming melalui Metode Simpleks. *Binus Bus. Rev.*, 4: 725-741