International Journal Of Science, Engineering, and Information Technology
Volume 08, Issue 01, December 2023
Journal homepage: https://journal.trunojoyo.ac.id/ijseit

Company Production Optimization Analysis Using Linear Programming Method (Case Study in Terang Alam Semesta MSMEs)

Agung Firdausi Ahsan[1], Rachmad Hidayat[2], Budyi Suswanto[3]

[1,3] Universitas KH. Bahaudin Mudhary Madura, Sumenep, Indonesia
[2] Universitas Trunojoyo Madura, Bangkalan, Indonesia

A B S T R A C T

The development of the industrial world which is increasingly developing at this time will lead to high competition in the industrial world. So that the profits of each company also have an influence. New ideas are urgently needed to bring the business world in a more advanced direction so that it can keep up with increasingly fierce competition. Terang Alam Semesta is one of the MSMEs that operates in the Bag Manufacturing Sector. In this research, the Linear programming method is used as an operational research model in applied mathematics studies which is widely used in industry and business organizations and can be used in the process of obtaining solutions and solving production problems. From the results of research using POM for Windows software, it was found that Terang Alam Semesta would gain maximum profits if it could produce 15 Premium Leather Bags and 10 Semi-Leather Bags with a profit of IDR. 900,000 per day.

Keywords: *Linear Programming, Optimization, UMKM*

Article History
Received 02 September 23 Received in revised form 01 October 23 Accepted 10 December 23

1. Introduction

Every business has the goal of improving the products produced and making a profit. The most basic goal of people running a business is to make a profit. Therefore, every business entity needs the best planning for the development of the business being run by creating new innovations and implementing a directed management system.[1]. In running a business, especially in the field of production, the company must be able to maximize the use of production factors such as raw materials, labor and production machines to obtain optimal results. The development of the business industry is accompanied by a very tight level of competition giving rise to various kinds of problems which also affect the breath of life. a business, especially in the convection production business sector. This is what causes similar small businesses or Micro, Small and Medium Enterprises to have to fight hard to be able to maintain the viability of their businesses now and in the future. Maximum profit is an important indicator that is a determining factor in the development of a business. The problem that most attacks business life, especially in the production sector, is the lack of ability to combine production factors and the ability to determine the number of products from the production output, so that quite a few people get less than optimal profits. Especially for Micro, Small and Medium Enterprises (MSMEs), this problem has a strong influence in hampering the development of a business [2].

MSMEs are a form of business that is a means of improving a nation's economy and increasing employment opportunities and their existence can increase the country's foreign exchange through taxes. MSMEs are a means of saving small communities from the brink of poverty. In running their business, MSME players hope that this can help improve the family's economy in meeting their needs. Therefore, to achieve the goals of their business, they must be able to obtain the maximum possible profit at the end of a certain period. The influence of micro, small and medium enterprises (MSMEs) in society is very large, especially in empowering people who do not have jobs[3]. At least individuals from society can fulfill their personal needs easily. The government hopes that the existence of MSMEs can fight poverty when economic conditions are weak, and can increase state foreign exchange or increase regional income through taxes which will later be used to improve people's lives and to implement equitable development of an advanced economy. The government's participation will be very helpful if MSMEs are actively managed and provided with assistance from various aspects so that MSMEs can increasingly develop and can change from small businesses

* *Corresponding author.*
E-mail address: agungfirdausi@unibamadura.ac.id.

E-ISSN 2548-4214

to large and strong businesses in dealing with various problems and challenges that confront the pace of industrial activity. Nevertheless [4], MSMEs also still have various obstacles in carrying out their business activities such as limitations in management, limited human resources, and minimal technological knowledge. Considering the large influence that has had on the existence of MSMEs, the government plays an important role in seeking to implement guidance and development so that they are able to overcome every problem they face to become more developed, advanced and independent so that the role of MSMEs in the economy becomes greater [5].

In previous research, according to Shuo Yu, The linear programming has clear steps and little computing complexity, which is helpful for dealing with the problem quickly. To transform the real problems into linear programming problems can demonstrate the impact of the various factors in the problems on the over-all results, which can not only demonstrate the restrictive conditions well, but also determine the optimal solution of the objective result under such restrictive conditions. It requires accurately and actually transforming the problems and determining the restriction factors and ultimate goals[6]. According to Syifa, the solution to this problem is applying a linear program using the simplex method. This method is suitable for solving optimization problems using the objective and constraint functions. To maximize profits, the objective function in this study is the price of each type of glass, while the constraint functions are the amount of production, the number of workers, the amount of clay, and the time for production[7]. According to Anggoro, when the supply of resources has not been maximally utilized, the profits obtained are not maximized. This is because the bakery star's home industry has not implemented linear programming and lack of understanding of mathematics in the production process that is done. Home industry star bakery conducts production planning using an approximate method of purchasing raw materials. This is one of the causes of not achieving maximum profits so that in the production process it is necessary to use linear programming to be able to use production inputs efficiently [8]. According to Jain, linear programming is a mathematical technique which is used to determine the optimal allocation of the limited resources, among the competitive activities provided all the relationships among the variables are linear. It is mainly concerned with a method of finding the optimum value (maximum or minimum) of a function of n variables. It is used extensively in business, economics, and engineering. An example of an engineering application would be maximizing profit in a factory that manufactures a number of different products from the same raw material using the same resources. The constraints would be decided by the amount of raw materials available. The problems related to product mix and distribution of goods are solved by the technique of linear programming for optimization. In a business setting, profit maximization in always emphasized which never means the minimization of some cost function. For linear programming problems, the simplex algorithm provides a powerful computational tool, able to provide fast solutions to very large-scale applications[9]. Meanwhile, according to Tesfaye, Linear programming is a method of allocating resources in an optimal way. It is one of the most widely used operations research tools to determine optimal resource utilization. Different products require different amounts of production resources at several stages of production. They also have different selling prices and, therefore, have different unit profits. The production process may also be subjected to different conditions. The linear programming technique will be used to determine the product mix that will maximize the total profit. It is the most flexible and extensively applied quantitative techniques. It is an efficient method for determining an optimal solution from a large number of alternatives to meet a specified objective function subject to various constraints and restrictions [10].

In Bandung, West Java, there are many Micro, Small and Medium Enterprises that are active in their business activities. With these efforts, it turns out that it creates social benefits, namely creating jobs easily so that the surrounding community becomes more productive and can improve their level of economic welfare. Apart from that, the benefits felt by the existence of these MSMEs are the availability of products that people need easily without having to buy in distant places at more affordable price comparisons. One of the MSMEs that is active and has the largest market potential in Bandung is Terang Alam Semesta. Terang Alam Semesta is a type of Micro, Small and Medium Enterprise which operates in the field of premium bag production. In carrying out its business activities, Terang Alam Semesta experiences problems in obtaining optimal profits. The main goal of Terang Alam Semesta to obtain maximum profits cannot always be achieved well and smoothly. This is due to a lack of ability to determine optimal production quantities in order to obtain maximum profits. At the end of each production period, the profits obtained by Terang Alam Semesta are not always constant. Previous research has similarities, namely how to increase production optimization so as to maximize the production process, while the difference is the object being studied. This is due to a lack of ability to determine optimal production quantities in order to obtain maximum profits. At the end of each production period, the profits obtained by Terang Alam Semesta are not always constant. Previous research has similarities, namely how to increase production optimization so as to maximize the production process, while the difference is the object being studied. This is due

to a lack of ability to determine optimal production quantities in order to obtain maximum profits. At the end of each production period, the profits obtained by Terang Alam Semesta are not always constant. Previous research has similarities, namely how to increase production optimization so as to maximize the production process, while the difference is the object being studied.

Considering that the number of requests continues to increase, this means that the number of consumers for products produced by MSMEs, especially at Terang Alam Semesta, will also increase, which should make Terang Alam Semesta continue to develop. However, the facts on the ground show something different because the profits received are unstable. The general and main problem faced by Terang Alam Semesta is the desire to obtain maximum profits using minimal costs but the lack of ability to utilize and combine the production factors at the same time appropriately. Bearing in mind that the production factors owned are also limited, so in reality the profits obtained at the end of each production in a certain period have not reached the maximum point. Lack of understanding and application of mathematics as well as limitations in utilizing existing resources are the main causes of not obtaining maximum profits. As a result of the non-optimal profits obtained, the business activities carried out have not experienced significant development for approximately 3 years in order to survive in the increasing business competition. From the problems that occur, this is a study in finding optimal solutions in the production sector both in optimal production quantities. as well as in terms of obtaining profits. To solve quantitative problems in the production sector, an analytical tool is needed to obtain a solution.

2. Literature Review

Optimization is the completion of the optimal output level in an economic project that cannot be separated from a series of alternative achievements. Optimization is a series of processes in finding the most optimal solution to a problem by utilizing analysis methods such as linear programming or non-linear programming. The optimal point in a business achievement is not simply obtained, but it is obtained with certain processes and techniques[11].

There are two optimization activities, namely maximization and minimization which are related to profits and costs. Maximization is the allocation of production inputs appropriately in order to obtain maximum income or profit, and minimization is the optimization of expenditure and appropriate use of resources to produce output at the minimum cost, a condition that contains a series of processes where the aim is to obtain the best solution from a product. Problems regarding maximization or minimization achieved through an objective function are called optimization.

The level of output that the company will receive will follow the level of limitations it has. The more production factors are used, for example raw materials, the amount of product income will also increase, which will have a significant effect on optimal profit generation. At that point the company can be said to have reached the optimization point. However, in reaching the optimization point, it is not uncommon for companies to experience non-constraint optimization and constraint optimization problems. Factors that become obstacles are ignored by companies in non-constraint optimization. This is different from optimization which has constraints where all forms of constraints are summarized in detail by a company, for example raw materials and production machines are interconnected with each other [12].

Companies must pay attention to and analyze every factor that becomes an obstacle or limitation to the problem's objective function, because that is what can determine the most optimal maximum and minimum values. Apart from that, the company must maintain every result and development of its business to use as reference material for future planning. In looking for solutions regarding maximizing profits and minimizing production costs which have elements of an objective function and a constraint function, a simplex method of linear programming analysis is needed. The nature of solving using the simplex method is related to linear, extensive and large systems with a simple but complicated algebraic method.

A business will always encounter obstacles in obtaining maximum profits. To allocate limited resources appropriately and efficiently in order to obtain maximum profits with minimal costs, the solution is to use the linear programming analysis method. The application of linear programming is not only in the industrial and economic fields but has been applied in various fields such as military and social.

Linear programming is a part of mathematics for optimizing a problem which includes decision variables and certain constraints and the solution is structured systematically. The mathematical model in linear programming must always be linear to obtain a solution to a problem. In linear programming analysis two methods can be used, namely the simplex method and the graphic method. The graphic method is used if the number of decision variables for a problem is only two (= 2 variables). Meanwhile, the simplex method is used if the number of decision variables in a problem is more than two (≥ 2 variables) [13].

The word "linear" means that all functions are systematic. Meanwhile, "programma" means planning. So it can be explained that linear programming is a systematic planning part of an activity to get optimal results.

The calculation method for carrying out the best planning among possible actions that a company can take in a business is called Linear Programming. The best decision making in planning can be done with various alternatives to achieve more specific goals with limited resources. In solving a linear program, there are two types of functions that must be determined and used, these functions consist of an objective function and a constraint function [14].

The objective function is a description of business goals or objectives to obtain a maximum level of profit or costs at a minimum level. Meanwhile, the constraint function is a form of mathematical model presenting the available constraints which will then be allocated optimally in a business activity. What are categorized as constraints are all limitations of production factors in a business that is being run. The following describes the characteristics of linear programming [15] :

1. Decision variables
   Decision variables are variables that describe the decisions to be made.
2. Objective function
   It is a function of a problem that will be maximized or minimized.
3. Barrier
   Constraints are the limits of the price of the decision variable.
4. Sign delimiter
   The restrictions that explain the price value of a decision variable in general mathematical linear programming mode can be stated as follows:

   Objective Function
   Maximize or minimize:
   $Z = c1x1 + c2x2 + \dots + cnxn$ **…… (1)**

   Fulfills the constraint requirements:
   $a11x1 + a12x2 + \dots a1nxn(=, \leq, \geq)b1$
   $a21x1 + a22x2 + \dots a2nxn(=, \leq, \geq)b2$
   ……
   $am1x1 + am2x2 + \dots amnxn(=, \leq, \geq)bm$
   $x1, x2 \dots , xn \geq 0$

The limiting function can be in the form of an equality (=) or inequality (≤ or≥). The symbols x1, x2 … , xn denote decision variables. The number of decision variables depends on the number of activities the company carries out to achieve its goals. The symbols c1 + c2 + ... + cn represent the contribution of each decision variable to the goal, also called the objective function coefficient in the mathematical model. The symbols a11, … , a1n, … amn represent the per unit use of the decision variable for limiting resources, or also known as the coefficient of the constraint function in the mathematical model. The symbols b1, b2, … bmn indicate the amount of each limited resource available. The number of constraint functions will depend on the number of limited resources. The last inequality x1, x2 … , xn ≥ 0 shows the limits where whether the price is negative, positive [15].

Completion of linear programs must be based on the standard form of modeling above to obtain the optimal solution. The basic terms that are characteristic of linear program modeling are as follows:

1. Linearity, this means that the properties of the objective function and constraint function must be linear.
2. Proportionality, meaning that the Z value in the use of resources can change according to the portion according to the level of activities carried out.
3. Additivity, meaning that the value of each goal of an activity that is not the same, will not influence each other.
4. Divisibility means that the value of the optimal result from each activity can be a fractional number.
5. Deterministic, meaning that all parameters in a linear program can still be known and determined with certainty.

The ability of linear programming is also accompanied by various weaknesses in its use. The weakness of using linear programming is that apart from its advantages, it can be completed using digital applications which make it easier for users to analyze, but if it is not supported by the use of a computer then completing analyzes that have more than two decision variables will be very difficult to complete manually. Apart from that, the results provided will not be optimal. The linear programming method cannot be used freely in every condition to solve a problem because it is limited by assumptions [16].

3. Results And Discussion

The data in this research comes from secondary data, where secondary data is data obtained by researchers indirectly or through intermediaries in the form of notebooks resulting from production activities at Terang Alam Semesta. The data collection technique in this research is using documentation techniques where this technique is part of a field study by taking data from research objects in the form of documents, photos or writings related to research data

where the data referred to in this case is a notebook of production activity results. from Terang Alam Semesta.

The data that has been obtained must be analyzed through a process using certain methods to turn the data into information. The data analysis technique used in this research is using the simplex linear programming method with the help of the POM-QM For Windows application. In the simplex method, there are several elements that must be determined first, where these elements are part of the steps to solve optimization problems in production activities. These elements are as follows [17]:

1. Decision Variables
   Formula : X1, X2 … , Xn **……. (2)**

2. Constraint/limitation function
   Formula : a1X1 + a1X2 +…+a1Xn(=, ≤, ≥)b1
   a2X1 + a2X2 + …+a2Xn(=, ≤, ≥)b2
   ……
   amX1 + amX2 + …+amXn(=, ≤, ≥)bm
   X1, X2 … , Xn ≥ 0

3. Objective Function
   Formula: Zmax/min = c1X1 +c2X2 + … + cnXn

The steps in solving optimization problems using the simplex linear programming method with the help of the POM QM For Windows application are as follows [18]:

1. Make sure the Pom-Qm For Windows application is installed on your computer.
2. Open the Pom-Qm For Windows application on the computer desktop.
3. Click module then select Linear Programming
4. Click the file menu then select new
5. In the title box, fill in the title of the case to be resolved
6. In number of constraints, fill in the number of constraint functions according to the case.
7. For number of variables, fill in the number of variables according to the case.
8. On the objectives menu, click maximize.
9. Click OK.
10. Enter all the numerical data into the table that appears then click solve.
11. Click the tile to display all the required data processing results.

4. Results And Discussion

Terang Alam Semesta has an MSME that produces 2 types of products, namely Premium Leather Bags and Semi Leather Bags. To produce both products, raw materials for silk yarn, raw materials for wool yarn and labor are needed. The maximum supply of silk thread is 60 kg per day, wool thread 30 kg per day and labor is 40 hours per day. The need for each product unit for raw materials and labor hours can be seen in the following table:

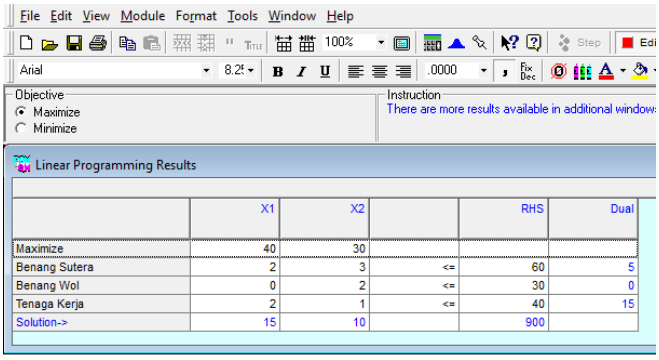
Table 1. Production Requirements

Types of raw materials and labor	Raw Materials (Kg) and Labor Time (Hours)		Maximum provision
	Premium Leather Bag	Semi Leather Bag	
Silk Thread	2	3	60 kg
Wool yarn	-	2	30 kg
Labor	2	1	40 hours

Both types of products provide profits of IDR 40 million for silk fabrics and IDR 30 million for woolen fabrics. How to determine the number of units of each type of product to be produced each day so that profits can be maximized.

Linear Programming Formulation

1) Determine
   Variable X1=silk cloth X2=wool cloth
2) Objective function
   Zmax= 40X1 + 30X2
3) Constraint / limitation function
   1. 2X1 + 3X2 ≤ 60 (silk thread)
   2. 2X2 ≤ 30 (wool thread)
   3. 2X1 + X2 ≤ 40 (labor)



	X1	X2		RHS	Dual
Maximize	40	30			
Benang Sutera	2	3	<=	60	5
Benang Wol	0	2	<=	30	0
Tenaga Kerja	2	1	<=	40	15
Solution->	15	10		900	

Figure 1. Linear Programming Results

The results of production optimization calculations using linear programming via the POM-QM For Windows application show that the combination of number of

products and profits obtained by Terang Alam Semesta in factual (real) conditions has not reached the optimal point. This is shown by the number of bag combinations produced and the profits obtained by Terang Alam Semesta in factual conditions that are different from optimal conditions. Even so, the number of bag combinations produced and the profits obtained in factual conditions are close to the optimal point.

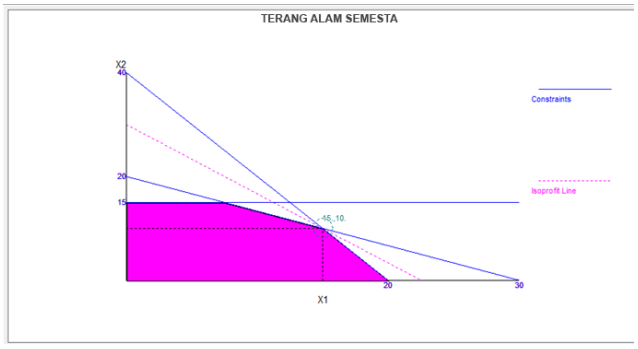


Figure 2. Linear Programming Formulation

The results of the Linear Programming analysis using the POM QM For Windows Application based on existing limitations are that Terang Alam Semesta will obtain maximum profits if it produces 15 Premium Leather Bags and 10 Semi Leather Bags with a profit of IDR 900,000 per day.

5. Conclusion

Based on calculations and analysis of Linear Programming using the POM QM For Windows Application, you will obtain optimum profits by producing 15 Premium Leather Bags ($x1$) and 10 Semi Leather Bags ($x2$), with a total profit of Rp. 900.00 per day if all goods are sold and no additional raw materials occur.

REFERENCES

[1] NWA Santi, IA Haris, and IN Sujana, "THE INFLUENCE OF SELLING PRICE AND SALES VOLUME ON UD REVENUE. PUTRA BROILERS IN BATUMULAPAN DUSUN KLUNGKUNG DISTRICT IN 2015-2017,"*J. Educator. Econ. Undiksha*, vol. 11, no. 1, p. 116, Jun. 2019, doi: 10.23887/jjpe.v11i1.20090.

[2] G. Sitorus, Y. Nasution, L. Nancy, E. Siregar, and A. Nainggolan, "ENTREPREUNERSHIP MINDSET FOR BEGINNER BUSINESSES IN THE ENVIRONMENT OF THE SOUTH JAKARTA COOPERATIVE AND SME DEPARTMENT,"*J. SYNERGY*, vol. 5, no. 01, pp. 7–15, Jul. 2023, doi: 10.59134/sinergi.v5i01.298.

[3] A. Halim, "THE INFLUENCE OF THE GROWTH OF MICRO, SMALL AND MEDIUM ENTERPRISES ON THE ECONOMIC GROWTH OF MAMUJU DISTRICT," vol. 1, no. 2, 2020.

[4] N. Rozaini and A. Nurfitriana, "The Influence of Umkm Social Assistance Funds on Economic Improvement in Communities in the City of Medan".

[5] S. Afifah, "The Impact of the Corona Virus Pandemic on MSMEs in Indonesia,"*EXERO J. Res. Bus. Econ.*, vol. 6, no. 1, pp. 63–82, June. 2023, doi: 10.24071/exero.v6i1.6687.

[6] S. Yu, "Applied Research of Enterprise Cost Control Based on Linear Programming,"*MATEC Web Conf.*, vol. 25, p. 03012, 2015, doi: 10.1051/matecconf/20152503012.

[7] EA Syifa*et al.*, "The Application of Linear Programming for the Optimal Profit of Pt. Naruna Using the Simplex Method," Manag. Syst. Prod. Eng., vol. 31, no. 2, pp. 138–143, Jun. 2023, doi: 10.2478/mspe-2023-0016.

[8] BS Anggoro, RM Rosida, AM Mentari, CD Novitasari, and I. Yulista, "Profit Optimization Using Simplex Methods on Home Industry Bintang Bakery in Sukarame Bandar Lampung,"*J Phys. Conf. Ser.*, vol. 1155, p. 012010, Feb. 2019, doi: 10.1088/1742-6596/1155/1/012010.

[9] Research Scholar, School of Science, Career Point University, Kota, Rajasthan, India*et al.*, "Application of Linear Programming for Profit Maximization of the Bank and the Investor," Int. J.Eng. Adv. Technol., vol. 8, no. 6, pp. 4166–4168, Aug. 2019, doi: 10.35940/ijeat.F9337.088619.

[10] G. Tesfaye, T. Berhane, B. Zenebe, and S. Asmelash, "A Linear Programming Method to Enhance Resource Utilization Case of Ethiopian Apparel Sector".

[11] A. Aksan, A. Rangkuti, and A. Ribal, "Optimization of CV.Amanda Makassar Production Planning in the Time of Covid-19 Using Multiple Goal Linear Program Model,"*J. Matt. Stat. And Computing*, vol. 17, no. 2, pp. 189–201, Dec. 2020, doi: 10.20956/jmsk.v17i2.11793.

[12] MA Kalwar, MA Khan, MF Shahzad, MH Wadho, and HB Marri, "Development of linear programming model for optimization of product mix and maximization of profit: case of leather industry,"*J. Appl. Res. Technol. Eng.*, vol. 3, no. 1, pp. 67–78, Jan. 2022, doi: 10.4995/jarte.2022.16391.

[13] OS Balogun, ET Jolayemi, TJ Akingbade, and HG Muazu, "Use Of Linear Programming For Optimal Production In A Production Line In Coca –Cola Bottling Company, Ilorin," vol. 2, no. 5, 2012.

[14] A. Rosmasari and WS Jatiningrum, "Production Optimization to Minimize Total Costs in Micro, Small and Medium Enterprises,"*J. System Engineering. Ind.*,

vol. 10, no. 1, pp. 15–26, Apr. 2021, doi: 10.26593/jrsi.v10i1.4491.15-26.

[15] R. Gusnandar and M. Hilman, "OPTIMIZATION OF SALE PRODUCTION AMOUNT USING LINEAR PROGRAMMING METHOD IN MURNI SARI SMEs IN WARUNG BATOK CILACAP,"*J.Ind. Galuh*, vol. 2, no. 2, pp. 55–62, Feb. 2023, doi: 10.25157/jig.v2i2.2967.

[16] T. Sriwidadi and E. Agustina, "Production Optimization Analysis with Linear Programming Using the Simplex Method,"*Binus Bus. Rev.*, vol. 4, no. 2, pp. 725–741, Nov. 2013, doi: 10.21512/bbr.v4i2.1386.

[17] EP Astutik, H. Faizah, and RR Wantika, "APPLICATION OF CASE METHOD ASSISTED WITH POM-QM SOFTWARE IN LEARNING LINEAR PROGRAMS,"*FIBONACCI J. Educator. Matt. And Matt.*, vol. 8, no. 2, p. 157, Dec. 2022, doi: 10.24853/fbc.8.2.157-164.

[18] M. Rifa'i, R. Saputra, ND Ardyanti, T. Prameswari, and R. Susanto, "Application of Linear Programming Simplex Method and POM-QM in Maximum Profit Analysis for Bu Siti Risoles MSMEs at Ledoksari Market, Surakarta," 2021.