PROFIT OPTIMIZATION AND COST EFFICIENCY OF PRODUCT MIX WITH LINIER PROGRAMMING SPREADSHEET MODEL: Case of Nanda Salad

OPTIMASI KEUNTUNGAN DAN EFISIENSI BIAYA BAURAN PRODUK DENGAN MODEL SPREADSHEET PEMROGRAMAN LINIER: Studi Kasus pada Nanda Salad

Yayang Novealita Wahono Putri*
yayangnovealitawahonoputri@gmail.com
Politeknik Negeri Malang

Nurafni Eltivia
nurafni.eltivia@polinema.ac.id
Politeknik Negeri Malang

Nur Indah Riwajanti
nur.indah@polinema.ac.id
Politeknik Negeri Malang

ABSTRACT

This research aims to provide the best model in order to optimize profits and minimize costs in the field of product mix at Micro Small Medium Enterprises called Nanda Salad, Malang, East Java, Indonesia. This research uses the Solver Spreadsheet Model to produce a Linier Programming scheme. The analysis method begins with the process of collecting data, constructing the model, defining the variables, construct the objective function, designing the model constraints, constructing the solution model, and implementing the solution. The results of this research indicate that profit optimization and cost efficiency can be obtained more optimally if Nanda Salad chooses to carry out production activities with on line 1 compared to on line 2. In addition to getting profit optimization and cost efficiency schemes, on line 1 shows that Nanda Salad can use their limited resources to produce of product mix optimally. By considering the average of return, Nanda Salad can optimally meet consumer demand without wasting costs. To increase the accuracy result, MSMEs can combine forecasting approaches with Linier Programming.

Keywords: Cost efficiency, Excel, Linier Programming, Product Mix, Profit Optimization

**Corresponding Author*

ABSTRAK

Penelitian ini bertujuan untuk memberikan model terbaik dalam rangka mengoptimalkan laba dan meminimalkan biaya terhadap produksi produk campuran pada Usaha Mikro Kecil Menengah bernama Nanda Salad, Malang, Jawa Timur, Indonesia. Penelitian ini menggunakan *Solver Spreadsheet Model* untuk menghasilkan skema *Linier Programming*. Metode analisis dimulai dengan proses pengumpulan data, membangun model, mendefinisikan variabel, membangun fungsi tujuan, merancang batasan model, membangun model penyelesaian, dan pengimplementasian solusi. Hasil penelitian ini menunjukkan bahwa optimalisasi laba dan efisiensi biaya dapat diperoleh dengan lebih maksimal apabila Nanda Salad memilih untuk menjalankan kegiatan produksi dengan skema *on line* 1 dibandingkan *on line* 2. Selain mendapatkan skema optimalisasi laba dan efisiensi biaya, skema *on line* 1 menjawab dengan jelas bahwa Nanda Salad dapat mempergunakan sumber daya yang terbatas untuk memproduksi produk campuran dengan optimal. Dengan mempertimbangkan rata-rata jumlah retur Nanda Salad dapat memenuhi permintaan konsumen secara optimal tanpa adanya kondisi pemborosan biaya. Untuk meningkatkan keakuratan hasil, UMKM dapat mengombinasikan pendekatan *forecasting* dengan *Linier Programming.*

Kata Kunci: Efisiensi biaya, Excel, *Linier Programming*, Optimalisasi laba, Produk Campuran

1. INTRODUCTION

Every company has its own goals to be achieved based to the company's vision and mission (Mariam, 2017). Overall, the industry's purpose is to obtain optimal net profit (Baki & Cheng, 2021). With globalization is happening in the all over the world, which is making competition among businesses increasingly tough. It has put enormous pressure on companies, especially small and medium-sized companies to achieve their main goals. Not that all it takes is for a business to gain competitive advantage and improve business performance simply through enterprise-level competition (Lian, 2018). Since the business environment is unpredictable and rapidly changing, businesses need to change and improve (Baki & Cheng, 2021). It means about their operations and practices through a new more comprehensive organizational strategy that extends from procurement to the end users. In Indonesia, Micro, Small and Medium Enterprises (MSMEs) are expected to become the backbone of the national economy. Based on research conducted in 2017 the number of MSMEs grew to more than 59,000,000 units, an increase of around 2% from 2016 (Azzahra & Wibawa, 2021). In 2019, reported that the MSMEs Gross Domestic Product (GDP) grew by Rp. 2,121.3 trillion from a base of Rp. 335.1 trillion from the previous year (Kristiyanti, 2012). MSMEs are synonymous with the characteristics of limited resources(Baki & Cheng, 2021). To answer these challenges, it is necessary to pay attention to profit optimization that reflects competitive ability. In line with profit optimization, MSMEs also need to pay attention to their cost's production. Most MSMEs do not have adequate production planning and control due to lack of knowledge and skills in that area, which means resources are not used properly

(Biswas & Chakraborty, 2016). MSMEs management is always having difficulty to find optimal level of production of planning, organization and control.

Therefore, MSMEs must focus plan and control their production, which can improve their profit and cost efficiency. It is mean that MSMEs always tries how to utilize limited resources to be able to produce optimal products. Many management issues relate to the efficiency of use, due to limited resources such as skilled labor, raw materials and capital to achieve the company's desired goals, namely efficiency cost scheme (Baki & Cheng, 2021). That focus especially for MSMEs that produce more than one type of output (product mix). The product mix problem is selecting the optimal product combination that maximizing gains in demand and resource constraints (Aghapour *et al.*, 2015). By reaching out an optimal product mix, allows companies to increase profits and minimize production costs. Companies can increase the net profit of a production line by 1.9% through product mix optimization and reduction of production costs from 5% to 10% (Ginting *et al.*, 2018). Thus, the use of company resources becomes efficient and wider production efficiency can be achieved. Linear Programming is an analytical planning technique whose analysis uses mathematical methods used to solve the problem of allocating limited resources and products so that product sales get a optimum profit considered with efficiency cost. One of the non-manual tools that can be used as a measure of profit optimization and cost efficiency as well as providing sensitivity analysis of input data is the Linear Programming Spreadsheet Model by Add-ins Solver features. Previous research using a similar method to the ABC company object. Several studies such as those conducted by (Tannady, 2017), (Wang & Li, 2017), (Fagoyinbo *et al.*, 2011), (Balogun *et al.*, 2012), (Haider *et al.*, 2016), (Maurya *et al.*, 2015) still using the manual linear programming formula, so the calculation process takes longer. Based on this gap, the researcher is interested in examining more deeply the use of Solver Add-Ins in the Spreadsheet Model to produce LP output more quickly and accurately. Nanda Salad is one of MSMEs in Malang, East Java, Indonesia. The background for selecting in the form of MSMEs, more specifically Nanda Salad because the characteristic of MSMEs are too limited resources and technology. Uniquely, however MSMEs remain the largest contributor to GDP (in the real sector).

Nanda Salad has a main product salad with four types of product mix. Determination of the product mix is based on the size of each different package. Companies often experience problems where they are sometimes unable to determine optimal production quantities in order to ensure that products are sold out without returns. However, this condition may result in lost opportunities to fulfill customer requests. Therefore, companies are faced with inefficient resource utilization making it more difficult to determine the optimal product mix for maximum profit, which is also to meet customer needs. Therefore, the company's management is always looking for how to make the right decisions in finding the optimal level of their product that needs to be produced and in at the same time maximizing company profitability. There are various theoretical and quantitative techniques that have been developed to evaluate this decision problem. One technique is a linear program with a spreadsheet model. The main aim of this research is to observe the current process in Nanda Salad production line for decision variables and identification of constraints and for formulating linear a programming model that suggests a feasible product mix to ensure optimum profit for the business. In particular, to effectively predict which products of its should pay more attention or be produced more elsewhere maximize

profits. This study will also help Nanda Salad management to make better decisions without waste of time and money. How this business optimizes the use of limited resources to maximize profit is the problem to be answered.

2. LITERATURE REVIEW

Profit Optimization

Optimization is a normative approach to identify the best solution in decision making from a problem. Optimization solving method mathematically through the allocation of limited resource among competing usage types (Eka Saputra, 2021). Profit optimization is related the number and type of goods produced by the company to generate the maximum profit. The problem of production optimization is to connects resource capacity with the number and type of products produced.

The company's goal is to get maximum profit or with the aim of minimizing costs, it doesn't mean that the optimal production is the same as the maximum production amount. Every company always tries to produce at maximum capacity because it will get a minimum unit cost however, if the demand is not as much as the maximum production amount, the company will not get optimal profits. This is because many goods are not sold. The effort that must be made is how the company utilizes these resources to produce products in order to gain profit (Baki & Cheng, 2021).

The concept of profit optimization is closely related to cost efficiency. Costs are categorized based on the object of expenditure, changes in the number of activities, the main functions in the company, the correlation of costs with something financed, and according to the terms of the benefit (Munawir, 2014). So, cost efficiency is way of achieving results in the most economical way (Ogbeide & Ejechi, 2018). This approach assesses efficiency by checking whether resources are used to produce the maximum output at the lowest possible cost (Mariam, 2017).

Concept of Linear Programming

As a mathematical techniques that aimed in optimizing performance in terms of combinations of resources (Yahya *et al.*, 2012). Linier Programming (LP) is useful for the allocation of scarce or limited resources to several competing activities on the basis of given criterion of optimality (Sharma, 2017). It is known for 2 kinds of functions, namely the objective function and constraint functions (Yulianto *et al.*, 2012). LP is also known as a mathematical technique to achieve profit maximization or cost minimization in a mathematical model whose requirements are represented by linear relationship (Aghapour *et al.*, 2015).

Linear programming helped in making optimum use of productive resources (Ogbeide & Ejechi, 2018). Linear programming techniques also offers practical and viable solutions as there may be different constraints operating beyond the problem that need to be considered. It also helps in revising the fundamental plan for a variety of situations. If there is some changes on the conditions whether decision variables or constraints when the linear programming model is partially achieved, the model can be controlled by changing or altering the conditions for the optimal results (Ezema & Amakom, 2012).

Linear programming is a mathematical technique that widely used in operation research or management science, in finding solutions to complex managerial decision problems that allows options between alternative courses of action (Yahya *et al.*,

2012). Linear programming can be used in solving product mix problems, production planning problems, assembly line balancing problem, transportation and assignment problems. Linear programming can also be applied in other areas such as agricultural planning, farm management, selecting air weapon system, education, hospital administration and capital budgeting (Sharma, 2017).

Product Mix Optimization

Product mix is also known as product assortment, which is a set of product items that a particular seller or manufacturer offers for sale to buyers (Baki & Cheng, 2021). Product mix strategy plays an important role in the manufacturing sector (Aghapour *et al.,* 2015). The management especially in a multi-product company often faces an allocation problem, where they have difficulty in finding the right amount of each product to be produced under the given constraints of the organization so that overall efficiency and profit can be maximized (Ezema & Amakom, 2012). This is also known as an optimization problem and can be solved through optimal product mix technique. Product mix adjustments can assist managers to increase profitability by focusing more on producing high-profit products. The optimal product mix enables the managers to solve major problems of maximizing profit and minimizing cost (Ogbeide, 2018).

Most of the researchers also have formulated a linear programming model with the objective function to maximize profit under the capacity constraint, demand constraint and raw materials availability (Wang & Li, 2017). In product mix problem, demand, cost and resource capacity are the most used constraints in the studies. In term of resource capacity, raw material availability and machine capacity are usually being considered in previous studies (Molina, 2018). From the previous research, it has helped the decision makers in the company in making decision for their production planning where they focusing more on high-sales products for their production (Maurya *et al.*, 2015).

Sensitivity Analysis

Sensitivity analysis is an analysis to be able to see the effects that will occur due to changing circumstances (Ogbeide & Ejechi, 2018). In real LP applications, the solution to a single model is hardly ever the end of the analysis. It is almost always useful to perform a sensitivity analysis to see how (or if) the optimal solution changes as one or more inputs vary. Two approaches to performing sensitivity analysis:

1. An optional sensitivity report that Solver offers.
2. An add-in called SolverTable.

Table 1. The comparison of Solver's Sensitivity Report and SolverTable

Solver's Sensitivity Report	SolverTable
Focuses only on the coefficients of the objective and the right sides of the constraints.	Allows you to vary any of the inputs.
Provides useful information through its reduced costs, shadow prices, and allowable increases and decreases.	Provides the same information, but requires a bit more work and some experimentation with the appropriate input ranges.
Based on changing only one objective coefficient or one right side at a time.	Is much more flexible in this regard.

Solver's Sensitivity Report	SolverTable
Outputs can be difficult to understand if you lack the necessary background.	Outputs are straightforward. You can vary inputs and see directly how the optimal solution changes.
Not available for integer-constrained models, and its interpretation is more difficult for nonlinear models.	Outputs have the same interpretation for any type of optimization model.
Comes with Excel.	Is a separate add-in, but is freely available.

Source: (Ogbeide & Ejechi, 2018)

3. RESEARCH METHOD

Type of Research

Type of research used in this research is descriptive quantitative research. Descriptive research is research conducted to determine the value of the independent variable, either one or more (independent) variables without making comparisons, or connecting with other variables (Sugiyono, 2015). Descriptive research is research conducted to describe certain symptoms, phenomena or events. Data collection is carried out to obtain information related to phenomena, conditions, or certain variables and is not intended to test hypotheses. Descriptive research was conducted to determine the value of the independent variable, be it one or more variables without making comparisons, or connecting one variable with other (Sugiyono, 2009). This descriptive research includes the presentation of conclusions through the presentation of statistics. The main purpose of the analysis is to provide an illustrative and/or summary description that can help readers understand the types of variables and their interrelationships.

The quantitative research method is a research method based on the philosophy of positivism, used to examine certain populations or samples, collecting data using research instruments, data analysis is quantitative/statistical in nature, with the aim of testing the hypothesis that has been established (Sugiyono, 2013). Based on the definition, it can be concluded that method quantitative descriptive research is a method that aims to create an objective picture or description of a situation using numbers, starting from data collection, interpretation of the data as well as the appearance and results. The selection of descriptive quantitative aims to provide an overview in the form of several alternative schemes that can be defined using numbers. Thus, it is hoped that the result of this study can be proven mathematically and accurately. As an aid in conducting quantitative research in this paper, a tool as well as an appropriate method is used in order to solve research problems, namely Spreadsheet Methodology.

Object

The object of this research is Nanda Salad which is located in Malang, East Java, Indonesia using operating data for a period of 3 (three) months in 2022 per days. So, the total of sample is 78. The three-months times frame option is determined by taking into account the relevance of the function and the current condition of a business so that measurements are close to the most suitable results to be used as a basis for decision-making and internal control.

Data Collection and Data Sources

Collection required in this study was carried out by collecting existing company data or records and also conducting interviews with the owner and founder of Nanda Salad regarding requests for fulfillment of data needs and confirmation of data that was still lacking to formulate a linear problem solving programming using the Microsoft Excel Model by Solver tool. The data needed in this study include:

1. Type of products
2. Cost of raw materials
3. Direct labor costs
4. Production process
5. Sales report
6. Production report

Analysis Step

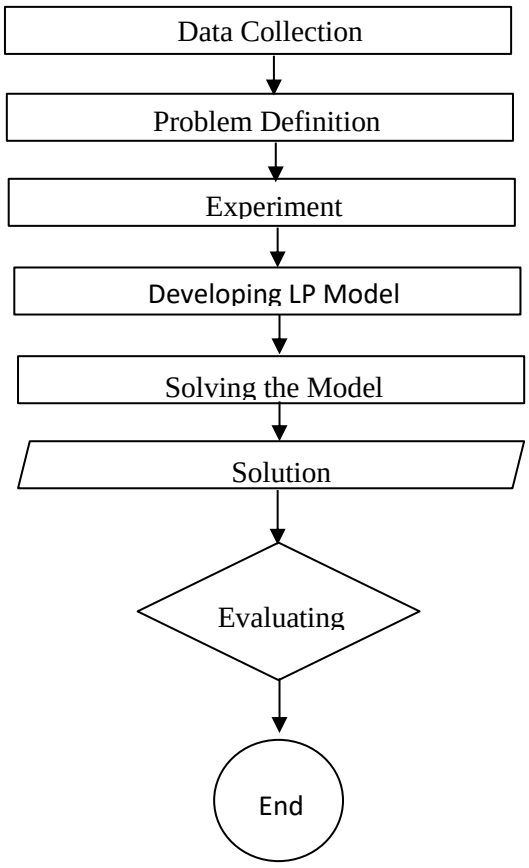

Figure 1. Research Procedure
Source: (Ogbeide & Ejechi, 2018)

Figure 1 above shows the procedures involved for this study. The first step is to identify a related problem in the study area by investigating and defining the identified problem. Then, a research on similar previous studies regarding the product mix problems and their proposed solutions have been studied in order to identify the best solving method for this problem. For this study, a case company is selected and primary and secondary data collection method has been used in order to gather relevant data from the company.

Figure 2 below shows the flow chart of constructing a linear programming model. To identify the decision variables, objective functions and constraints of the company, observation on the production line process and an interview session with the owner of Nanda Salad has been conducted. And additional secondary data sources were used to get accurate information. Then, the data collected were analyzed to develop a LP model.

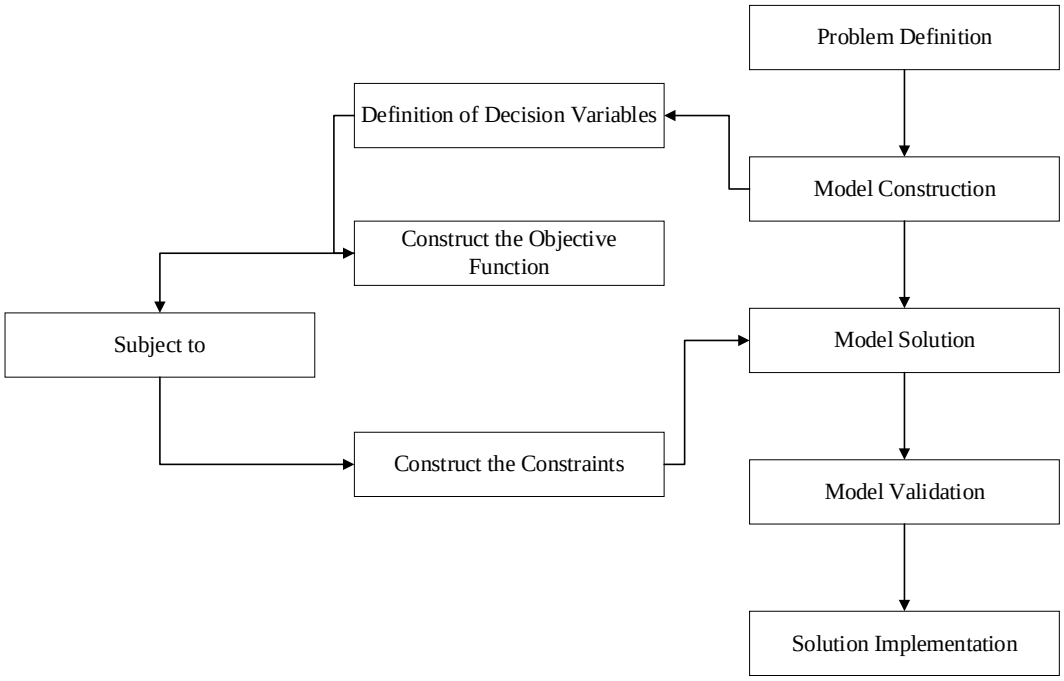

Figure 2. Flowchart Illustrates Construction of LP Model

Source: (Ogbeide & Ejechi, 2018)

The method of this research is Spreadsheet Methodology with 3 (three) steps below (Sikder *et al.*, 2018):

Develop the Spreadsheet Model

Inputs

All numerical inputs—that is, all numeric data given in the statement of the problem— should appear somewhere in the spreadsheet.

Decision variable cells

Instead of using variable names, such as x, use a set of designated cells for the decision variables. The values in these changing cells can be changed to optimize the objective.

Objective cell

One cell, called the objective cell, contains the value of the objective. The solver systematically varies the values in the changing cells to optimize the values in the objective cells. The cells must be linked to the changing cells by formulas.

Constraints

Excel does not show the constraints directly on the spreadsheet. Instead, they are specified in a Solver dialog box.

Nonnegativity

Normally, the decision variables—that is, the values in the changing cells—must be nonnegative. Check the appropriate option in the Solver dialog box.

4. RESULT AND DISCUSSION

This research is conducted at Nanda Salad. Nanda Salad is a MSMEs company which located in Malang, East Java, Indonesia. This company was established on 2012. Nanda Salad is a salad manufacturing company. There are three main products of Nanda Salad; Type 1-250ml, Type 2-350 ml, and Type 3-5000 ml. The products of Nanda Salad are distributed all around East Java. However, Nanda Salad confronted an issue with unpredicted (accurately) the best quantity of produced based on their product mixed which has affected the profit optimization and cost efficiency. That is why the management wants to make a better decision to improve the productivity which has given impact in profit and cost.

This research will focus on three major products of Nanda Salad sales of each product in Nanda Salad in year 2022 for three months (September-November) as a focused. From the interview in the production process of this company, findings data regarding the decision variables and constraints. The data for the constraints is summarized in tables below.

Data Research

Table 2. Labor Cost Listed

Description	Total (Rp)
Cost per labor-day shipping	6.250
Cost per labor-day production, on line 1	7.500
Cost per labor-day production, on line 2	6.600

Sources: data processed by author (2022)

Table 3. Input Data

	Type 1-250ml	Type 2-350ml	Type 3-500ml
Labor hours for shipping	4	3,5	2
Labor hours for production, line 1	4	4,25	5
Labor hours for production, line 2	3,25	3	3,5
Shipping cost	6.250	6.250	6.250
Selling price	15.000	20.000	30.000
Total sales, on line 1	1.185.000	1.240.000	1.410.000
Total sales, on line 2	1.185.000	1.200.000	1.200.000
Unit margin, tested on line 1	13.750	23.750	48.750
Unit margin, tested on line 2	5.200	11.675	34.350

Sources: data processed by author (2022)

Table 4. Production Plan

	Type 1-250ml	Type 2-350ml	Type 3-500ml
Number produced on line 1	84	65	50
Number produced on line 2	79	60	40
Total computers produced	163	125	90
	<=	<=	<=
Maximum sales	180	150	100
Objective			430
Average of return on line 1	5	3	3
Average of return on line 2	0	0	0

Sources: data processed by author (2022)

Table 5. Constraints

	Used		Available
Minimum sales	1.185.000	<=	2.000.000
Maximum Shipping cost	6.250	<=	7.000
Minimum produced (total)	90	<=	100

Sources: data processed by author (2022)

Table 6. Net Profit per Day

Profit	Type 1-250ml	Type 2-350ml	Type 3-500ml	Total
Produced on line 1	1.155.000	1.543.750	2.437.500	5.136.250
Produced on line 2	410.800	700.500	1.374.000	2.485.300

Sources: data processed by author (2022)

Data Analysis

By using non-negativity constraints formula X1, X2, X3>=0, Linier Programming with Excel Solver can be presented as follows.

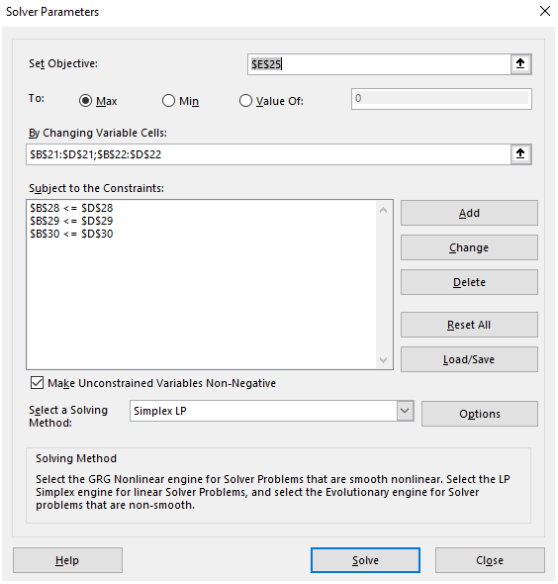

Figure 3. Solver Parameters
Sources: data processed by author (2022)

Microsoft Excel 16.0 Linearity Report
Worksheet: [Product Mix Schemes.xlsx]Sheet4
Report Created: 10/12/2022 21:04:30

Table 7. Objective Cell (Max)

Cell	Name	Original Value	Final Value	Linear Function
$E$36	Total	12536	12536	**Yes**

Cell	Name	Cell Value	Formula	Linear Function
$B$28	Minimum sales Used	1.185.000	$B$28<=$D$28	**Yes**
$B$29	Maximum Shipping cost Used	6.250	$B$29<=$D$29	**Yes**
$B$30	Minimum produced (total) Used	90	$B$30<=$D$30	**Yes**

Sources: data processed by author (2022)

Microsoft Excel 16.0 Sensitivity Report
Worksheet: [Product Mix Schemes.xlsx]Sheet4
Report Created: 10/12/2022 21:04:30

Table 8. Constraints

Cell	Name	Final Value	Constraints R.H. Side	Allowable Decrease
$B$28	Minimum sales Used	1.185.000,00	2.000.000	815.000
$B$29	Maximum Shipping cost Used	6.250,00	7.000	750
$B$30	Minimum produced (total) Used	90,00	100	10

Sources: data processed by author (2022)

A sensitivity analysis can be carried out based on the optimal solution as shown in Table 6. The dual value of the model constraints in Table 7 indicates that the profit will increase if the allocation for the constraint is increased by one unit.

Table 9. Suggested Optimal Solution

Description	Type 1-250ml	Type 2-350ml	Type 3-500ml
Number produces on line 1	79	62	47
Number produces on line 2	79	60	40
Net profit on line 1	1.086.250	1.472.500	2.291.250
Net profit on line 2	410.800	700.500	1.374.000

Sources: data processed by author (2022)

Based on the findings in this study, it is clear that the results are the answer to the objective. This optimal solution helps the Nanda Salad management in fully utilized all the resources efficiently. By producing according to the optimal solution, the company will be able to optimize the profit and reduce the cost to be cost efficiency.

5. CONCLUSION

This research focused on a MSMEs as a case study with the purpose of applying Linier Programming (LP) for profit optimization and cost efficiency for product mix. This research has developed a LP model by Microsoft Excel Methodology using Solver by identifying the problem definition and then build a model construction. This process will produce a definition variable and followed by construct the objective function, decision variables, and construct the constraints trough finding of the model solution and give the company a solution implementation.

Based on the solution offered through the LP Solver Excel Model, it is recommended to produce mixed products using line 1 with details of 79 packs (type 1), 62 packs (type 2), and 47 packs (type 3) respectively. By producing so many units, the company can optimize a profit of Rp2.291.250,00 higher around Rp917.250,00 (Rp2.291.250,00 – Rp1.374.000,00) with a minimum total cost (not exceeding the constraints) with max Rp3.000,00 per pack. On the other hand, line 1 has calculated the average return received by the company every day. By choosing a production scheme on line 1, the company is expected to be able maximize profit and reduce cost and maintain the availability of consumer demand can be fulfilled optimally without wasting their resources that have been spent.

However, there are several limitations for this research. Linier Programming (LP) cannot be used for forecasting. It is a snapshot for current situation. If any new constraints will be added and decision variables, the entire of models need to be changed. Based on the limitation above, it is recommended for the company to use hybrid method such as simulation and LP. This research will provide benefits for management to determine the best model for production activities that will be carried out in the near future or are being carried out. So, the company maybe can continue using LP method and explore the possibility such as for cost efficiency (cost minimization) and also profit optimization.

REFERENCES

Aghapour, A. H., Gunasekara, H. L., & Zailani, S. (2015). *Linear Programing Applications ; A single-Case Study in Tea Industry The Optimization Problem of Product-Mix and Linear Programing Applications ; A single-Case Study in Tea Industry*. Australian Journal of Basic and Applied Sciences, *9*(3), 7–18.

Azzahra, B., & Wibawa, I. G. A. R. P. (2021). Strategi optimalisasi standar kinerja UMKM sebagai katalis perekonomian indonesia dalam menghadapi middle income trap 2045. *Inspire Journal: Economics and Development Analysis*, *1*(1), 75–86. https://ejournal.uksw.edu/inspire/article/download/4856/1771

Baki, S. M., & Cheng, J. K. (2021). A linear programming model for product mix profit maximization in a small medium enterprise company. *International Journal of Industrial Management*, *9*, 64–73. https://doi.org/10.15282/ijim.9.0.2021.5956

Balogun, O. S., Jolayemi, E. T., Akingbade, T. J., & Muazu, H. G. (2012). Use of linear programming for optimal production in a production line in Coca–Cola bottling company, Ilorin. *International Journal of Engineering Research and Applications*, *2*.

Biswas, S., & Chakraborty, A. (2016). Importance of production planning and control in small manufacturing enterprises. *International Journal of Engineering Science Invention*, *5*(6), 61–64.

Eka Saputra, V. M. (2021). *OPTIMASI PERENCANAAN PRODUKSI DENGAN METODE LINIER PROGRAMING PADA INDUSTRI KERIPIK TEMPE SANAN MALANG "TOKO VELODROM."* Universitas Muhammadiyah Malang.

Ezema, B. I., & Amakom, U. (2012). Optimizing profit with the linear programming model: A focus on golden plastic industry limited, Enugu, Nigeria. *Interdisciplinary Journal of Research in Business*, *2*(2), 2046–2057.

Fagoyinbo, I. S., Akinbo, R. Y., Ajibode, I. A., & Olaniran, Y. O. A. (2011). Maximization of profit in manufacturing industries using linear programming techniques: Geepee Nigeria Limited. *1st International Technology, Education and Environment Conference*, *1*(1–2), 159–166.

Ginting, M., Kirawan, M., & Marpaung, B. (2018). Product mix optimization on multi-constraint production planning-a Fuzzy Mixed Integer Linear Goal Programming (FMILGP) approach: A single case study. *MATEC Web of Conferences*, *204*, 2004.

Haider, Z., Fareed, R., Tariq, M. B., Usman, S., Din, N. U., & Khan, M. S. (2016). *Application of Linear Programming for Profit Maximization: A Case of Paints Company, Pakistan*. International Journal of Management Sciences and Business Research, 5(12*)*, 141–151

Kristiyanti, M. (2012). *Peran strategis usaha kecil menengah (UKM) dalam pembangunan nasional*. Majalah Ilmiah Informatika, 3, 15.

Lian, C. L. (2018). *Competitive Advantage of Malaysian Small Medium Enterprises: Impact of Supply Chain management Practices, environmental Uncertainty and Supply Chain Flexibility*. Asia e University.

Mariam, O. O. (2017). *Inventory Control and Profit Maximization in a Manufacturing Company; A Case Study of Nigeria Distillereis Limited, Sango Otta Ogun State*. Departement of Accounting, Faculty of Management Science, National Open University of Nigeria.

Maurya, V. N., Misra, R. B., Anderson, P. K., & Shukla, K. K. (2015). Profit optimization using linear programming model: A case study of Ethiopian chemical company. *American Journal of Biological and Environmental Statistics*, *1*(2), 51–57. https://doi.org/https://doi.org/10.11648/j.ajbes.20150102.12

Molina, M. G. (2018). Product mix optimization at minimum supply cost of an online clothing store using linear programming. *International Journal of Applied Mathematics Electronics and Computers*, *6*(3), 33–38. https://doi.org/https://doi.org/10.1039/b000000x

Munawir, S. (2014). *Analisa Laporan Keuangan (17th ed.)*. Liberty Yogyakarta.

Ogbeide, D., & Ejechi, J. O. (2018). Product Mix Optimization in the Manufacturing Industry: A Linear Product Mix Optimization in the Manufacturing Industry: A Linear Programming Approach. *Journal of Economics and Finance*, *2*(2), 263–275.

Sharma, J. K. (2017). *Operations Research Theory And Applications* (6th ed.). Laxmi Publications.

Sikder, J., Mahmud, T., Banik, B., & Gupta, S. (2018). *Linear Programming To Find The Critical Path Using Spreadsheet Methodology*. August, 10–13. https://doi.org/10.9790/0661-2003024850

Sugiyono. (2009). *Metode Penelitian Bisnis*. CV Alfabeta.

Sugiyono. (2013). *Metodologi Penelitian*. Media Press.

Sugiyono. (2015). *METODE PENELITIAN & PENGEMBANGAN*. CV Alfabeta.

Tannady, H. (2017). Optimasi Produksi Meubel Menggunakan Model Pemrograman Linear. *Business Management Journal*, *10*(1), 1-9.

Wang, Y., & Li, L. (2017). Manufacturing profit maximization under time-varying electricity and labor pricing. *Computers & Industrial Engineering*, *104*, 23–34. https://doi.org/https://doi.org/10.1016/j.cie.2016.12.011

Yahya, W. B., Garba, M. K., Ige, S. O., & Adeyosoye, A. E. (2012). Profit maximization in a product mix company using linear programming. *European Journal of Business and Management*, *4*(17), 126–131.

Yulianto, A. W., Suyitno, H., & Mashuri, M. (2012). Aplikasi Fuzzy Linear Programming Dalam Optimalisasi Produksi. *UNNES Journal of Mathematics*, *1*(1) 7-14.