

Application of Linear Program Based on Simplex Method in Profit Maximization of Wahyu Chips Business in Sidrap Regency South Sulawesi

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ABSTRACT

Application of Linear Program based on Simplex Method in Profit Maximization of Wahyu Chips Business in Sidrap Regency, South Sulawesi. Thesis of Business Administration Major, Faculty of Social Sciences and Law, Makassar State University. This study aims to determine the application of the linear programming model based on the Simplex method in optimizing production so as to achieve maximum profit at the Wahyu Chips Business. The type of research used is descriptive qualitative, which is an analysis used to create a systematic overview so as to provide solutions related to problems by applying the simplex method linear program in the production process to achieve maximum business profits. To achieve the research objectives, data collection techniques are used, namely observation, interviews, and documentation with four informants who are owners and employees of the Wahyu Chips Business. The results of the research by applying a linear program based on the simplex method assisted by the POM - QM for Windows V.5 application show that the Wahyu Chips Business has produced with production conditions almost reaching optimal conditions. To obtain maximum profit, Wahyu Chips Business must produce 1,933 pcs of balado banana chips, 3,500 pcs of original sweet potato chips, and 5,000 pcs of balado sweet potato chips, so that it will increase profits by 3% from the factual condition which is Rp. 2,625,377,-.

Keywords : Linear Programming, Profit Maximation, Simpleks Method

INTRODUCTION

The development of the business world today shows very rapid development along with technological developments including business in the industrial sector. One of the developments in the business world occurs in the industrial sector, especially in the processing industry. This processing industry is a field of work of a company in processing products into valuable products. Widyawati (2014) argues that the industrial sector needs to be developed because it is part of the national development planned by the government. Indonesia is a country known as an agrarian country that has diverse natural resources, especially the agricultural and plantation sectors and every community has the opportunity to manage these natural resources to create a more valuable product. This can be an opportunity for people in an area to increase business in the food processing industry by using the maximum available resources. A growing industry with

abundant availability of raw materials will create competitiveness so that it affects each industry to increase its business.

Each industry is oriented towards maximum profit by utilizing resources as optimally as possible. Therefore, each company is required to carry out careful planning with a directed management system. Activities engaged in production, especially in the food processing industry sector, must maximize the use of production factors such as raw materials, labor, and production machinery to obtain maximum profit and optimal production. Good planning can make it easier for companies to optimally manage their resource capacity in the production process. Production is always related to raw materials and labor. But in reality the industry experiences many obstacles and failures to achieve these goals.

One of the food processing industries, namely the Wahyu Chips Business according to the results of pre-observation, found a problem where the company is oriented to maximize company profits but is unable to utilize production factors such as raw materials, labor, and limited production machinery. So, from the results of this pre-observation, several phenomena were obtained, namely, (1) the absence of careful production planning, (2) the use of non-optimal production factors, (3) the profit obtained was not maximized.

This waste will result in the profits earned from the business becoming less than optimal if done continuously and eventually suffer losses. If left unchecked, this will reach the stage where the company is no longer able to run because there is no value added that can be used when price fluctuations occur which will certainly affect the continuity of the company. Athanassiou (2018) says that one of the things that can be done in getting maximum profit is to conduct a cost analysis where businesses can analyze and monitor overhead costs. Understand every detail of the costs incurred in the process of running the company, both production costs, distribution costs, and operations. Businesses can improve the efficiency of company operations by improving production and distribution processes, reducing waste, and using more effective technology. Therefore, there is a need for reference in the company to use methods in determining product combinations and the use of appropriate production factors as an effort to increase efficiency and reduce operational costs that are not actually needed.

One of the efforts to increase profits is to plan production. The tool that is usually used in conducting production planning uses linear programming analysis based on the Simplex method. Linear programming analysis based on Simplex method is a tool that can help a company in production activities to plan and can be considered in making decisions on how to allocate existing resources.

In its solution, linear programming based on simplex method will be solved with the help of POM QM software. POM-QM itself is software commonly used in the field of operational management to make it easier to determine and calculate the maximum profit that a company can generate for each production in a certain period of time according to the company's needs, so that it will produce accurate calculations and is

expected to simplify and speed up the calculation process which will have an impact on maximizing company profits.

RESEARCH METHODS

This research uses a descriptive qualitative research approach with a retrospective case study research type. Retrospective case study is a type of research that allows treatment to be continued by further researchers who are more competent in their fields, while researchers only provide input from the research results (Endraswara, 2012). This research was conducted at Mrs. Iwali's Wahyu Chips Home Industry located at Poros Soppeng Street, No. 79 C, Amparita Village, Tellu Limpoe District, Sidrap Regency, South Sulawesi with a research focus on the application of linear programs based on the simplex method. Data were collected by conducting interviews, observations, and documentation. The data analysis technique used was descriptive qualitative analysis using the Miles, Humberman, and Saldana model (Miles et al., 2014), namely data collection, data condensation, data presentation, and conclusion drawing with data validity checking focusing on using source triangulation, technique triangulation, and member check. Furthermore, for quantitative data, further data analysis was carried out using a linear program based on the simplex method with the help of POM-QM software.

RESULTS AND DISCUSSION

1. Existing Conditions of Production Factors in the Wahyu Chips Business

a. Quality of Raw Materials

Researchers first discussed the findings about the existing conditions of the production factors owned by Wahyu Chips Business on raw materials, namely researchers conducted research focusing on the quality of raw materials used in Wahyu Chips Business. In accordance with the results of observations and interviews, the Wahyu Chips Business uses cassava and young bananas as the main raw materials along with supporting raw materials such as oil, cayenne pepper, balado seasoning, flavoring, and other supporting raw materials. The main raw materials of cassava and young bananas are obtained from suppliers who collaborate with Wahyu's Chips Business. This makes it easier for Wahyu Chips Business to control the quality of the raw materials to be obtained. This is in line with the opinion of Cempakasari & Yoestini (2003), reliable cooperation with raw material suppliers will provide better understanding and understanding of the needs and needs of each party so as to increase business profits. Reinforced by the opinion of Christofer & Memarista (2019), namely if the basic ingredients or basic needs of the supplier are not good, the company's performance will also definitely decline. This means that when companies and suppliers do not have good cooperation related to controlling the quality of raw materials, it will have an impact on the company's performance.

Wahyu Chips Business itself controls the quality of raw materials used regularly and consistently. The company maintains the quality of raw materials by looking at the condition of the raw materials. It's just that in the company there is no standard quality to assess raw materials, such as the minimum weight of raw materials, the minimum length

of raw materials, and so on. This is not in line with the opinion of Wahyuni (2021), to achieve the desired product quality, a quality standardization is needed. Even without a standardized quality standard, Wahyu Chips Business still maintains the quality of raw materials so that it is feasible to make products even without a standardized quality standard. This is in accordance with the opinion that quality output is produced from raw materials in good condition and vice versa, if the raw materials are in poor condition, it will produce poor products (Imam et al., 2014).

b. Labor Specifications

Furthermore, for labor research that focuses on labor specifications, based on the research results, Wahyu Chips Business itself has a limited workforce. The workforce that works to carry out production totals four people including the owner. The workforce in this company is still flexible or does not work in full every day. The division of labor has been carried out quite clearly despite the fact that the jobdesk is sometimes still done by one worker because of the flexible nature of the workforce and not working full time. Working hours for production are also not set permanently, only according to the availability of labor, with a vulnerable time of 8 - 14 hours / day.

In addition, the incentive system is also not always given every month, incentives will only be given according to the performance of the workforce when there is more demand than usual. The company, which is still classified as a home-based business, makes the company choose to manage the business with a limited workforce. The results of this study are not in line with the opinion of Oktarini (2016) who concluded in his research that the greater the number of workers, the value of productivity will increase in a company. This means that an increase in the number of workers will increase profits. Even so, the use of labor must be adjusted to the company's ability to produce products in accordance with the company's targets and the company's ability to provide incentives to labor. This statement is in line with Anugrah et al. (2018), the use of labor occurs based on the increasing demand for goods.

c. Production Machinery

The production machines owned by the Wahyu Chips Business are still relatively simple. The production machines are raw material cutting machines, blenders, and stoves. This production machine is in accordance with the results of observations and interviews conducted, the production machine has a function to cut sweet potato raw materials into the right size for chip production. The blender itself is used to smooth the spices used for the original seasoning of sweet potato chips. The existence of this production machine helps the company to speed up the production process. However, because the condition of the machine is still very simple, the capacity that can be accommodated by the cutting machine itself is still limited. It is not possible if the machine is used to produce raw materials in large quantities for a long period of time. Although still limited, the production machine has a positive impact on the company's productivity. This simple machine also does not require expert operators or technicians to use it because the

production machines used are easy to set up and adjust their use. This is in line with the opinion of Febriyanti & Fatma (2018) who say that product reliability and quality are important. The company must be able to ensure that all production tools and machines function optimally without any interruption, so that the target production quantity and product quality can be achieved as targeted.

2. Determinant Factors of the Production Process in the Wahyu Chips Business

a. Raw Material Inventory

This raw material determinant factor focuses on the company's ability to provide the required raw materials. In accordance with the research results, it is concluded that the supply of raw materials is carried out by cooperating with suppliers from Barru Regency and Wajo Regency (Siwa) for cassava raw materials while for young bananas it is still in the Sidrap Regency area. The main supplier who often conducts transactions with Wahyu Chips Business is a supplier from Barru Regency.

Based on the results of the research, Wahyu Chips Business in conducting raw material inventory uses two suppliers and the main supplier from Barru Regency. When the main supplier experiences crop failure due to weather factors or uncertain seasons, the Wahyu Chips Business will supply raw materials from suppliers in Waji Regency (Siwa). In providing raw materials, the Wahyu Chips Business still has limitations such as erratic weather, causing suppliers to sometimes lack raw materials. In addition, when the harvest is not optimal, the price of raw materials will also increase. Fluctuations in raw material prices are also an obstacle to raw material supplies because the capital owned by the company is still limited so that it cannot afford to buy more expensive raw materials.

Thus, the company collaborates with two suppliers which makes the company have other options in the event of limited raw materials from the main supplier by looking for a backup supplier so as to facilitate coordination in the event of limited raw materials. Because companies must be able to prepare raw material stocks properly and consistently so that the production process continues and the business will get consistent profits as well. The raw materials used for production should be continuous, so that they can be used during the lean season and the rainy season (Mukodiningsih et al., 2015). The raw material inventory that must be carried out by the company is not only to prepare raw material stock, but must pay attention to the quality of each raw material used.

The company collaborates with families/suppliers in Wajo Regency (Siwa) to maintain and control raw materials so that they continue to be available, this collaboration is carried out to anticipate when there is a crop failure or price fluctuation, so that a price that is more easily accessible to the company's capabilities can be given. The results prove that although there are still some limitations in the availability of raw materials, the company is also looking for other alternatives to maintain the continuity of the company's production. The results of this study are in line with the opinion of Arfiyanto & Purnama (2022) which states that raw material control is needed to maintain the stability of raw materials so that it affects the smooth production process of the company.

b. Labor Performance

The labor determinant factor focuses on the performance of the workforce to carry out the production process of goods. The Wahyu Chips business, which is still considered a home-based business with limitations, makes this business only run by four people, including Mrs. Iwali as the owner. The existing workforce is the family of the owner. The business also still uses simple tools. Thus, the company has not conducted training and development for each worker to improve the skills of the workforce. The company considers that there is no need for training or development because the skills used also do not require special expertise in production. This is not in line with the opinion of Purwodono et al. (2018) who say that companies need to provide learning and training for workers to improve poor performance, learn new knowledge and technology and skills to adapt to the times.

However, according to researchers, it should be noted that not all companies have access or the ability to conduct appropriate training and development for the workforce. There is limited capital, limited connections, and other limitations if small-scale companies conduct training and development. Therefore, special assistance is needed from the private sector or the government in providing training assistance to every small business that has limitations. As stated by Nurhalita & Imsar (2022), the government, which has the authority and power to make policy decisions, should cooperate with the private sector to provide training to local businesses in order to survive and develop their businesses in the future.

In addition, a flexible work schedule is one of the factors that determine production in the Wahyu Chips Business. According to the results of the research, the workforce who are still in school and work elsewhere make some stages of production take longer on weekdays. Unlike production carried out on holidays which can be completed faster. The flexible work schedule causes production stages such as cutting raw materials and sterilizing raw materials to be carried out in the afternoon or evening, depending on when the workforce finishes their activities. On holidays, these stages can be done from morning to noon. Even so, the understanding of each individual to work together in managing the business helps in understanding the expectations of the company to achieve the desired production targets. Communication that continues to run well and an understanding of the jobdesk that must be completed helps the company to continue to carry out production to maintain the sustainability of the company. In accordance with the opinion of Irnanda et al., (2019), human relations in a company can maximize the dynamism of a company. The existence of activities and understanding of the people who are members of the company allows the company to achieve its goals.

c. Maintenance of production machinery

The production machinery determinant factor focuses on the maintenance of the business's production machinery. The results show that the enterprise uses simple production machinery in carrying out its production activities, namely raw material

cutting machines, blenders, and stoves. In the production process, the raw material cutting machine, which is specialized in cutting cassava into chips, is used more frequently, so it requires special attention compared to other production machines. Even so, there is still maintenance for other production machines, such as cleaning for blenders and stoves that have been used to maintain the durability of these production machines.

The maintenance of the raw material cutting machine is carried out by Mr. Yusuf as the person responsible for the production machine. Mr. Yusuf's expertise is an advantage for the company because it will reduce repair costs and maintenance costs if there is damage to the production machine. Maintenance is carried out in accordance with the observation results, carried out periodically by checking all parts of the machine that may experience damage. This will help the company to detect damage early and minimize the chance of major damage if regular monitoring is carried out and maintenance is adjusted to the use of the machine. In accordance with the opinion of Islam et al., (2020), irregularity in carrying out maintenance can cause the machine to experience interference or damage, which ultimately results in downtime and hinders the smooth production process. To ensure that the production process runs according to plan, good and planned machine maintenance is needed. This will support the reliability of the machine so that it can be used optimally.

3. Application of Linear Program based on Simplex Method

Researchers then conducted further analysis related to quantitative data that had been obtained using linear program analysis based on simplex method. Production inventory data for one period using data in April according to the results of documentation and interviews at the research location which are then described in a table to make it easier to understand and used to conduct further analysis using a linear program based on the simplex method. The production data for the April 2023 period are:

Table 1. Production Factor Inventory April 2023 Period

No	Production Factor	Inventory	Unit	Price
1.	Primary Raw Materials			
a.	Cassava	1.500	Kg	Rp. 1.200.000
b.	Young Banana	250	Kg	Rp. 335.000
c.	Cooking oil	256	Kg	Rp. 4.000.000
d.	Cayenne Pepper	6	Kg	Rp. 60.000
e.	Balado Seasoning	24	Kg	Rp. 45.000
f.	Flavoring	0,5	Kg	Rp. 10.000
2.	Labor	264	Jam	-
3.	Production Machine	102.5	Jam	-
3.	Operasional Costs			Rp. 1.800.000
4.	Production Constraint			-
a.	Original Potato Chips	3500	Pcs	

- b. Potato Balado Chips 5000 Pcs
c. Banana Balado Chips 1500 Pcs

Production optimization in Wahyu Chips Business is limited by constraints to facilitate calculations using a linear program based on the simplex method. Based on this, production optimization to achieve profit maximization is carried out using indicators according to Siswanto (2007), namely:

a. Decision Variable

Decision variables in the linear program based on simplex method are products produced by a business. In this study using products produced by Wahyu Chips Business in April 2023, resulting in three decision variables, namely:

Table 2. Decision Variable of Wahyu Chips Business

No	Decision Variable	Symbol
1	Banana Balado Chips 35 gram	X_1
2	Original Potato Chips 35 gram	X_2
3	Potato Balado Chips 35 gram	X_3

So, from the table it can be seen that the decision variables in the Wahyu Chips Business are Original Sweet Potato Chips with the variable symbol X_1 , Balado Sweet Potato Chips with the symbol X_2 , and Banana Chips with the variable symbol X_3 .

b. Objective Function

The objective function is the profit from each product produced which is the value of the difference between the selling price and the production cost per piece of product. The selling price set is adjusted to the market price while the production cost is in accordance with the cost of production of each raw material used along with other operational costs. So that from the research data, the following objective function model can be formulated:

$$\text{Objective Function: Max } Z: 306X_1 + 537X_2 + 474X_3$$

c. Constraint Function

Wahyu Chips Business in producing chips is inseparable from the constraints or limitations that affect the production process. These limitations consist of production factors, namely raw materials, labor, and production machinery, as well as other supporting costs (operational costs of raw materials). The amount of raw material availability in one period in April 2023 is used as the coefficient value of raw material usage. For labor, optimal time is used in the process of making chips. The limited use of machinery in the production process is the coefficient value of production machinery. While operational costs are the entire amount of expenses used in the production process. The description of the limitation function is as follows:

Cassava	: $35X_2 + 35X_3$	$\leq 1.500.000$
Young Banana	: $35X_1$	≤ 250.000
Cooking oil	: $18X_1 + 11X_2 + 11X_3$	≤ 256.000
Balado Seasoning	: $2X_1 + 2X_3$	≤ 6.000
Cayenne Pepper	: $0,3X_2$	≤ 24.000
Flavoring	: $0,02X_1 + 0,02X_2 + 0,02X_3$	≤ 500

Production Machine	: $15X_1 + 40X_2 + 40X_3$	≤ 396.000
Labors	: $53X_1 + 50X_2 + 50X_3$	≤ 950.400
Operational Cost	: $186X_1 + 186X_2 + 186X_3$	$\leq 1.800.000$
Banana Balado Chips (X_1)		≥ 1.500
Original Potato Chips (X_2)		≥ 3.500
Balado Potato Chips (X_3)		≥ 5.000

After determining the decision variables, objective function, constraint function. Furthermore, the data is processed using linear program data analysis based on simplex method with the help of POM - QM for Windows software. The results of the analysis using a linear program based on the simplex method using the POM - QM for Windows V.5 application according to the data obtained during the research, the Wahyu Chips Business will get maximum profit when the company produces 1,933 pcs of balado banana chips, 3,500 pcs of original sweet potato chips, and 5,000 pcs of balado sweet potato chips with a profit of Rp. 2,625,400, - in one month.

Table 3. Comparison of Factual and Optimal Production

No	Product Type	Variable	Production Rate (pcs)	
			Factual	Optimal
1	Banana Balado Chips	X_1	1.500	1.933
2	Original Potato	X_2	3.500	3.500
3	Potato Balado Chips	X_3	5.000	5.000

The comparison related to the benefits obtained in factual conditions and optimal conditions is as follows:

Table 4. Comparison of Factual and Optimal Profits

No	Product Type	Variabel	Profit Rate	
			Factual	Optimal
1	Banana Balado Chips	X_1	283.500	365.377
2	Original Potato	X_2	910.000	910.000
3	Potato Balado Chips	X_3	1.350.000	1.350.000
Amount			2.543.500	2.625.377

The results of calculations using data analysis of linear programs based on simplex methods with the help of POM - QM for Windows V.5 software show that the combination of the number of products and profits obtained by Wahyu Chips Business in factual conditions (real) not reached optimal production. This is described from the number of combinations of chips obtained and the profits obtained based on factual data in the field with the results of production optimization using a linear program based on the simplex method.

Based on table 3, the factual conditions of production with the optimal conditions of production are not much different. Based on the results of the linear program, it shows that companies with limited production factors need to increase the production of banana balado chips (X_1) by 1,933 pcs. In accordance with the data obtained previously, the company in the April period generated a gross profit of Rp. 10,000,000, - with a profit of Rp. 2,543,500, -/month. After applying the linear program, it was found that the company

was able to achieve maximum production with a production amount of 10,433 pcs of chips which resulted in a gross profit of Rp. 10,433,000,

Based on table 4, Wahyu Chips Business gets a profit of Rp. 2,543,500, - for the period of April 2023 based on factual production conditions. Meanwhile, if the company produces based on optimal conditions, the company will get a profit of Rp. 2,625,377, - every month. From factual conditions with optimal production conditions, there is an increase in company profits of Rp. 81,877, - or 3%. So it can be concluded that to achieve maximum profit every period, Wahyu Chips Business must produce according to optimal conditions.

The results of the study by applying a linear program based on the simplex method in maximizing company profits by optimizing production are effectively used to increase company profits. This is in line with the results of previous research conducted by Susanto (2021) which obtained an increase in profit of Rp. 23,600, - with a reduction in working time by 9.29 hours and research by Da Silva et al (2022) which achieved an increase of 94% of company revenue. This shows that the application of a linear program based on the simplex method helps companies reach the most optimal point in production to generate maximum profit.

CONCLUSION

Based on the discussion and description of the research results that have been carried out and looking at the objectives of this study, it can be concluded that the existing conditions of production factors, namely the main raw materials used are cassava and young bananas. The company does not have permanent employees who are given monthly incentives and the company still uses simple production machines used to support the company's production process. The determinants of the production process are influenced by the production factors used, namely the availability of raw materials, labor performance, and maintenance of production machinery. For the application of linear programs based on the simplex method with the help of POM - QM for Windows software, the steps are: (a) determining indicators, namely decision variables, objective functions, and constraint functions; (b) running POM - QM software; (c) entering data into the software; (d) analyzing data by selecting solve in the software, so that later the software will show optimal production data, and Wahyu Chips Business experienced a 3% increase in profit with an increase in profit of Rp. 81,877,- if the company carried out optimal production. By optimizing production factors, the company's profit in the factual condition resulted in a profit of Rp. 2,543,500, - increasing in the optimal condition of Rp. 2,625,377.

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