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Maximizing Culinary Business Profit with the POM-QM Simplex Method

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ABSTRACT

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Optimizing profit in Micro, Small, and Medium Enterprises (MSMEs) poses a common challenge for owners, particularly in the culinary sector. This study explores the potential application of the simplex method to maximize profits in "Martabak Pak Amir," a Martabak business. Utilizing POM-QM software, the research identifies key variables influencing Martabak business profits, including production costs, selling prices, production time, and profits from three Martabak variants. The simplex method, a linear programming problem-solving approach, iteratively develops solutions to achieve optimal outcomes. Data collected from observations and interviews with Martabak Pak Amir over a two-week period are utilized. The enterprise offers three Martabak variants: chocolate, pandan, and cheese. Through linear programming and simplex method analysis, the optimal calculation reveals that producing the pandan variant three times yields a maximum profit of Rp 8,100,000 monthly, with total monthly sales of Rp 4,764,000 or 397 portions of pandan Martabak sold per month.

1. Introduction

Profit optimization in Micro, Small and Medium Enterprises (MSMEs) is a common challenge faced by entrepreneurs, especially in the culinary sector (Azmi, Lubis, and Sembiring 2019). Amidst intense competition and various operational constraints, business owners often face difficulties in improving the profitability of their business (Pal 2014). One example of a culinary business that faces this challenge is the martabak business, which is one of the most popular and in-demand foods in the community (Andyarini 2020). In this context, the simplex method emerges as a mathematical solution that can be applied to reach the optimal point in maximizing martabak business profits (Dianti 2017). By considering various factors such as production cost, selling price, and production capacity, business owners can use the simplex method to identify the most efficient strategy to increase their business profitability (Haludin 2023). As culinary business opportunities grow in various regions, a deep understanding of the simplex method can be a valuable asset for MSME entrepreneurs to develop and strengthen their businesses (Zainol 2018).

The culinary industry in Indonesia, particularly micro, small, and medium enterprises (MSMEs), is a highly potential and quickly expanding sector (Candra et al. 2022). Food is an essential requirement, and micro, small, and medium enterprises (MSMEs) offer a wide range of culinary choices for consumers. Due to the expansion of the middle class and the adoption of fast food and street food as a result of changing lifestyles, there is a substantial increase in demand for the culinary industry (Baker et al. 2020). Micro, Small, and Medium Enterprises (MSMEs) in the sector have a crucial role in fulfilling this requirement by providing a variety of distinctive and cost-effective food items (Berinyuy 2022).

Nevertheless, maximizing earnings in culinary enterprises is a challenging endeavor, despite the significant potential. Micro, Small, and Medium Enterprises (MSMEs) frequently encounter obstacles such as constrained financial resources, volatile costs of raw

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materials, and fierce rivalry (Clark, Reed, and Sunderland 2018). For martabak firms, the issues they face may involve effectively controlling manufacturing costs, establishing competitive selling prices, and determining optimal production capacity (Gaffar et al. 2022). The implementation of suitable and effective strategies, such as the simplex method, is crucial in this context (Huangfu and Hall 2018). Hillier (2021) simplex approach, a linear programming tool, can help businesses identify the most advantageous blend of business variables that impact revenues. This application enables business owners to discern the most efficient methods for allocating their finite resources, minimizing expenses, and augmenting profit margins (Kodithuwakku and Rosa 2002). Furthermore, the utilization of tools such as POM-QM helps expedite and streamline the analytical procedure, yielding more precise and dependable outcomes. MSMEs in the food industry can increase their operational effectiveness and maintain their competitiveness in a market that is always changing by implementing this technology (Singh et al. 2019).

Adiningrat (2023) culinary industry in Indonesia, particularly micro, small, and medium enterprises (MSMEs), is a highly potential and quickly expanding sector. Food is an essential requirement, and MSMEs offer a wide range of gastronomic choices for consumers (Badriyah, Tri, and Prastiwi 2023). Due to the expansion of the middle class and the shift towards fast food or street food consumption, there is a substantial increase in demand for the culinary industry (Pal et al. 2014). Micro, Small, and Medium Enterprises (MSMEs) in the sector have a significant impact in fulfilling this demand by providing a variety of distinctive and cost-effective food products (Virmani, 2022). Nevertheless, maximizing earnings in culinary enterprises is a challenging endeavor, despite the significant potential for success (Ashley and Roe 2002). Micro, Small, and Medium Enterprises (MSMEs) frequently encounter obstacles such as restricted financial resources, volatile costs of raw materials, and fierce rivalry (Hamisi 2011). For enterprises such as martabak, the issues they face may involve effectively controlling manufacturing costs, establishing competitive selling prices, and determining optimal production capacity (Azimuddin 2023). This is where using sensible and effective techniques, like the simplex method, comes into play.

The simplex approach, a linear programming tool, can help entrepreneurs identify the most favorable combination of business variables that impact revenues (Cabinova and Fedorcikova 2021). This application enables business owners to discern the most efficient methods for allocating their finite resources, minimizing expenses, and augmenting profit margins. Furthermore, the utilization of tools such as POM-QM helps expedite and streamline the analytical procedure, yielding more precise and dependable outcomes (York and Venkataraman 2010). Within this particular setting, the simplex technique presents itself as a promising mathematical instrument that can aid MSMEs in effectively controlling their profitability (Beynon, Jones, and Pickernell 2018). An in-depth comprehension of this mathematical framework can offer useful insights for owners of companies in addressing the issues of profit optimization (Hussain, Zhang, and Seema 2023). Prior studies have demonstrated many strategies for handling profits in MSMEs, however, a significant number of these approaches do not prioritize the utilization of sophisticated mathematical techniques like simplex (Abbasi and Baleanu 2023). Some studies may not use sophisticated optimization models, instead focusing more on broad aspects of marketing or operational management. With regard to applying the simplex approach, this gap offers a chance for our research to provide a more focused and comprehensive contribution. This research examines the actual application of the simplex technique in culinary businesses. It not only addresses a gap in the existing literature but also offers MSME owners a helpful tool to enhance their profitability.

In order to maximize earnings for MSME businesses, this study intends to investigate the possible use of the simplex approach. This research aims to uncover the crucial characteristics that impact the profitability of martabak firms by applying the mathematical framework of the simplex approach. This research aims to develop a mathematical model that can help business owners effectively manage a martabak firm by taking into account numerous constraints and limitations, ultimately leading to increased efficiency and profitability.

2. Critical Review

The simplex method is a linear programming technique designed to find the optimal solution to optimization problems (Dantzig 1990). In the context of a martabak culinary business, this method can be used to determine the best combination of variables that affect profit, such as raw material costs, selling prices, and production capacity (Nandiyanto 2020). The use of POM-QM software in applying the simplex method allows for a faster and more accurate analysis process (Ashley and Roe 2002). This software can process data and run the necessary iterations to find optimal solutions with high efficiency, which is difficult to achieve with manual calculations (Valiev et al. 2010). Previous research shows that linear programming methods can significantly improve the operational efficiency and profitability of businesses (Tyteca 1997). The implementation of the simplex method in a case study of a small and medium-sized enterprise has been shown to be helpful in identifying the best strategy for resource management and decision-making (Engineering and Informatics 2020). By using POM-QM, the calculation and analysis process becomes easier and more accurate, which

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in turn can help martabak businesses to achieve maximum profits.

The efficiency of raw material cost management is one of the key factors in optimizing profits. The simplex method helps in determining the optimal amount of raw materials that should be purchased and used in the production process to minimize costs and maximize output (Afrizawati et al. 2022). By using POM-QM software, entrepreneurs can analyze raw material data comprehensively and get accurate results on the best combination of raw materials required. Ghodsypour and O'Brien (1998) shows that the linear programming method can assist in the management of raw material costs by providing an optimal solution that considers various constraints and restrictions that exist. In addition, a study by Budiasih (2013) indicated that the use of the simplex method in raw material management can significantly reduce waste and improve operational efficiency (Terdpaopong 2021).

Setting a competitive selling price is an important element in the marketing strategy of a culinary business. The simplex method allows entrepreneurs to determine the optimal selling price based on an analysis of production costs, desired profit margins, and market conditions. By using POM-QM software, entrepreneurs can model various pricing scenarios and choose the most profitable one. Saryoko (2016) found that linear programming can be used to develop more accurate and effective pricing models. This is supported by Simkin & Giovannucci's (2018) research which shows that optimization methods can assist companies in setting competitive selling prices, which in turn can increase profitability.

Maximizing profitability and attaining operational efficiency are contingent upon having an optimal production capacity. The simplex technique enables entrepreneurs to calculate the most advantageous level of output by considering the available capacity and market demand. The utilization of POM-QM software enables entrepreneurs to efficiently and precisely conduct this analysis, facilitating informed decision-making regarding production size. A study conducted by Rohmatin et al. (2021) demonstrated that the implementation of optimization techniques can substantially enhance production capacity by identifying the most efficient production levels that align with market demand. Furthermore, as per the research conducted by Haqq and Budiwitjaksono (2019), the utilization of the simplex approach can aid small and medium-sized businesses in efficiently controlling their production capacity, hence contributing to monthly earnings.

Overall, this study proposes that the application of the simplex method with the help of POM-QM software can provide practical and effective solutions to the various challenges faced by culinary businesses in optimizing profits. By identifying and managing key variables such as raw material costs, selling prices, and production capacity, this method offers a comprehensive approach to improving operational efficiency and business profitability.

3. Method Innovation

This research focused on martabak MSMEs located on Jl. Merdeka Barat, Pontianak. The research data was obtained through direct observation as well as intensive interviews conducted over a two-week period with the business owner, Mr. Amir. The method applied in this research is the simplex method, a mathematical approach used to optimize profits in the Martabak business. The data that has been collected is used as the basis for analysis to find the optimal solution to increase business profitability. With a systematic approach and using appropriate analytical tools, this research aims to provide valuable insights for MSME business owners in managing and improving their business performance.

Linear programming is a mathematical approach used to identify and solve problems in a systematic way. The definition of linear programming given Susanti (2021) states that it is a mathematical method in linear form to achieve an optimal solution by maximizing or minimizing an objective function against a number of existing constraints. In general, the goal of linear programming is to find the optimal solution to a problem by maximizing or minimizing a certain objective function.

$$Zmax = c1x1 + c2x2 + c3x3 + \cdots + cnxn \qquad (1)$$

Constraints:

$$a11x1 + a12x2 + \cdots + a1nxn = b1$$
$$a21x1 + a22x2 + \cdots + a2nxn = b2$$
$$\vdots + \vdots + \vdots + \vdots = \vdots$$
$$am1x1 + am2x2 + \cdots + amnxn = bm \qquad (2)$$
$$x1, x2, \cdots, xn \geq 0$$

Notes:

$c1, c2, \cdots, cn$: objective function coefficients

$x1, x2, \cdots, xn$: decision variable to be determined $a11, a1n, a1n, a1n$: constraint function coefficients $b1, b2, \cdots, bm$: number of constraint functions.

Modeling a linear program, the first step is to identify the decision variables that affect the goal to be achieved. The objective function is then formulated as a mathematical representation of the objective, while the functional constraints that limit the achievement of the objective must also be identified. By considering these three components, an effective mathematical model can be built to solve optimization problems in linear programming.

One popular method for tackling problems involving linear programming that seeks to determine ideal values in the presence of multivariate variables and inequalities is

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the Simplex method (Sellva Budianti et al., 2020). This methodology employs an iterative procedure with the objective of generating efficient solutions for addressing optimization challenges (Aini et al., 2021). The simplex approach can be employed either manually or through the utilization of software tools like POM-QM.

The manual implementation of the simplex technique starts by identifying the decision variables, which are subsequently transformed into mathematical expressions. After that, the constraint function and the objective function are determined and given the proper mathematical expression. In the subsequent phase, the construction of the Simplex table is carried out by identifying the pivotal columns and pivotal rows. The key columns are chosen based on the most negative value for maximizing the objective function, and the most positive value for minimizing the objective function. The key row, however, is found by finding the shortest index obtained by dividing the right value by the components in the key column (Knuth and Plass 1981). After then, an iterative procedure is carried out to modify the decision factors and update the Simplex table's values until no additional negative values remain outside the key row (Delingette 1999).

Software like POM-QM is essential to streamline and expedite the calculation process while guaranteeing the correctness of the output Fauzian (2024), even if manual simplex method computation necessitates in-depth knowledge and careful labor. Thus, academics and practitioners engaged in the study and optimization of systems based on linear programming may find that using such software proves to be a practical option.

4. Innovation Results and Discussion

According to the factor analysis results, there is a substantial correlation between the MSME performance construct and the related measurement variables, as evidenced by the high loading factor value of the construct. Nevertheless, the Cronbach's alpha reliability rating for this construct fell below the intended criterion (0.688), suggesting possible inconsistencies in measurement. In order to tackle this issue, it is necessary to conduct a more thorough assessment of the tools utilized to measure the concept.

Conversely, the Innovation construct has a substantial loading factor value and satisfactory reliability (Cronbach's alpha = 0.819), suggesting that this construct is dependable in assessing innovation within the setting of MSMEs. Similarly, the construct of Service quality, with a high loading factor value and strong dependability (Cronbach's alpha = 0.845), demonstrates that it is a dependable measure of the quality of services offered by MSMEs.

Nevertheless, it is important to acknowledge that certain components of the MSME performance framework may require additional assessment in order to enhance the accuracy and dependability of measurements. A consistent and trustworthy picture of the innovation and service quality offered by MSMEs may be obtained through the use of the measurement instruments employed in this study, as evidenced by the acceptable loading factor and dependability values of the Innovation & Service Quality constructs.

Changing the objective function and constraints is a crucial step in the process of linear programming to achieve an optimal solution. The objective function, denoted as Zmax, aims to attain the maximum value. To modify the given objective function, it can be rewritten into a new equation by shifting all variables to the left-hand side of the equation and setting the right-hand side to zero. Thus, the new objective function will be defined as:

$$Zmax - 2{,}400{,}000X1 - 2{,}700{,}000X2 - 2{,}200{,}000X3 = 0 \quad (3)$$

Furthermore, the constraints must also be adjusted to incorporate slack variables (S) representing the surplus capacity or resource shortages in meeting these constraints. For instance, the constraint for production time can be rewritten as;

$$7X1 + 7X2 + 7X3 + S1 = 21 \quad (4)$$

Similarly, the constraints for production cost and selling price can be modified by adding the corresponding slack variables:

$$3{,}000{,}000X1 + 3{,}000{,}000X2 + 3{,}000{,}000X3 + S2 = 9{,}000{,}000 \quad (5)$$

$$12{,}000X1 + 12{,}000X2 + 23{,}000X3 + S3 = 47{,}000 \quad (6)$$

By adjusting these objective function and constraints, the linear programming calculation can proceed to find the optimal solution that satisfies the given constraints.

The process of solving linear programming problems using the simplex method involves several steps, which are systematically presented and discussed. Initially, equations are formulated to represent the objective function and constraints, and these are organized into tables for clarity and ease of analysis. Key columns and rows are then determined to identify pivotal elements in the simplex tableau. Subsequently, new row values are calculated based on the key column values, and adjustments are made to non-key row values accordingly. The transfer of new row values is then carried out, leading to the determination of an optimal solution. In the presented example, the simplex method is applied to maximize profit in a Martabak business, resulting in specific production recommendations. Additionally, the process is reiterated using POM-QM software, highlighting the convenience and accuracy facilitated by computational tools. Overall, the combination of manual calculation methods and software-based solutions offers comprehensive insights

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into linear programming optimization, aiding decision-making processes in various practical contexts.

The simplex method was effectively used in this study to maximize revenues for Martabak Pak Amir's company. The decision-making process utilized the simplex technique to take into account constraints such as time to production, production costs, and selling prices. The implementation of POM-QM software was successful in facilitating and accelerating computations, leading to precise and dependable results.

The research findings suggest that in order to attain a monthly profit of Rp 8,100,000, Martabak Pak Amir's business needs to create three times the amount of Martabak Manis Srikaya (X2) version. The target is to attain a total of 397 units sold per month, which would result in a sales revenue of Rp 4,764,000. These findings offer helpful suggestions for business owners to efficiently allocate resources in order to maximize firm earnings.

In summary, this study establishes that the simplex approach is a dependable and effective strategy for resolving optimization issues in micro, small, and medium-sized enterprises (MSMEs), specifically in the culinary sector. The research findings can be used as a guide for other MSME practitioners to make strategic decisions that will improve their firm profitability by utilizing suitable optimization methodologies.

5. Conclusion

The results showed that to achieve maximum profit, Pak Amir's Martabak Business needs to increase the production of the Sweet Citrus Martabak variant. This finding provides valuable recommendations for business owners in optimizing resource allocation and increasing profitability. Overall, this study confirms that the simplex method is a reliable and efficient approach in addressing optimization challenges in Micro, Small, and Medium Enterprises (MSMEs), especially in the culinary industry. The results of this study can provide guidance for other MSME players in making strategic decisions to increase their business profitability.

6. Image and Data Table

Table 1. Compilation of equations

NB	X1	X2	X3	S1	S2	S3
Z	-2,400,000	-2,700,000	-2,200,000	0	0	0
S1	7	8	7	1	0	0
S2	3,000,000	3,000,000	3,000,000	0	1	0
S3	12,000	12,000	23,000	0	0	1

Source: processed by the author

Table 2. Key Column Determination

NB	X1	X2	X3	S1	S2	S3
Z	-2,400,000	-2,700,000	-2,200,000	0	0	0
S1	7	8	7	1	0	0
S2	3,000,000	3,000,000	3,000,000	0	1	0
S3	12,000	12,000	23,000	0	0	1

Source: processed by the author

Table 3. Key Line Determination

NB	X1	X2	X3	S1	S2	S3	NK
Z	-2,400,000	-2,700,000	-2,200,000	0	0	0	0
S1	7	8	7	1	0	0	24
S2	3,000,000	3,000,000	3,000,000	0	1	0	9,000,000
S3	12,000	12,000	23,000	0	0	1	4,800,000

Source: processed by the author

Table 4. New Key Row Value

NB	X1	X2	X3	S1	S2	S3	NK
Z							
S1	7	8	7	1	0	0	24
S2							
S3							

Source: processed by the author

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Table 5. Value conversion

Z	-2,400,000	-2,700,000	-2,200,000	0	0	0	0
-2,700,000	0.875	1	0.875	0.125	0	0	3
	-37,500	0	162,500	337,500	0	0	8,100,000
S2	3,000,000	3,000,000	3,000,000	0	1	0	9,000,000
3,000,000	0.875	1	0.875	0.125	0	0	3
	375,000	0	375,000	-375,000	1	0	0
S3	12,000	12,000	23,000	0	0	1	4,800,000
12,000	0.875	1	0.875	0.125	0	0	3
	1,500	0	12,500	-1,500	0	1	4,764,000

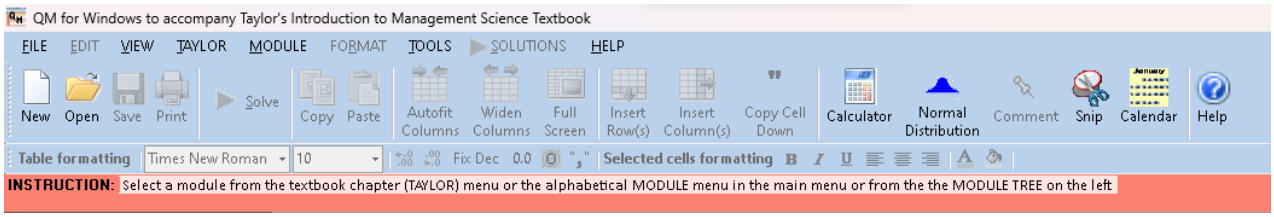
Source: processed by the author

Table 6. Moving the New Row Value

NB	X1	X2	X3	S1	S2	S3	NK
Z	-37,500	0	162,500	337,500	0	0	8,100,000
S2	375,000	0	375,000	-375,000	1	0	0
S3	1,500	0	12,500	-1,500	0	1	4,764,000
X2	0.875	1	0.875	0.125	0	0	3

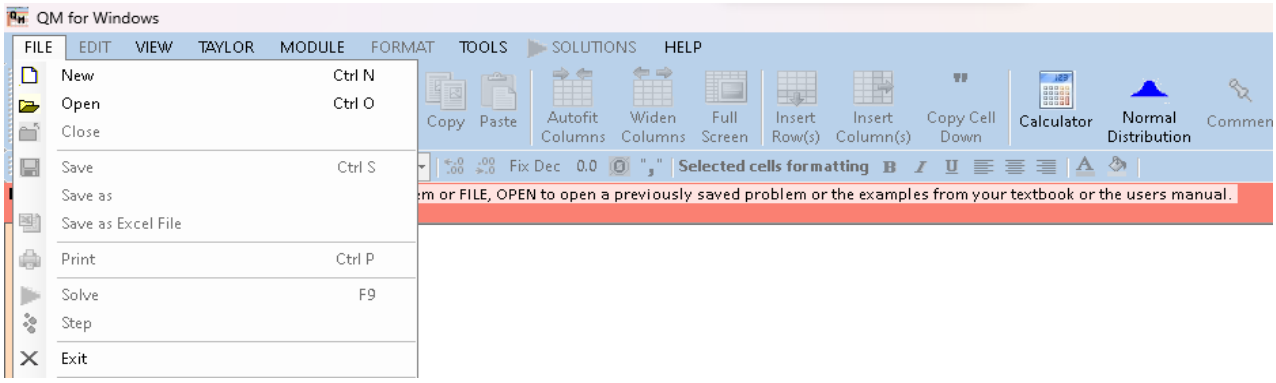
Source: processed by the author

Figure 1. Data QM



Source: processed by the author

Figure 2. Data QM



Source: processed by the author

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Figure 3. Data FLP

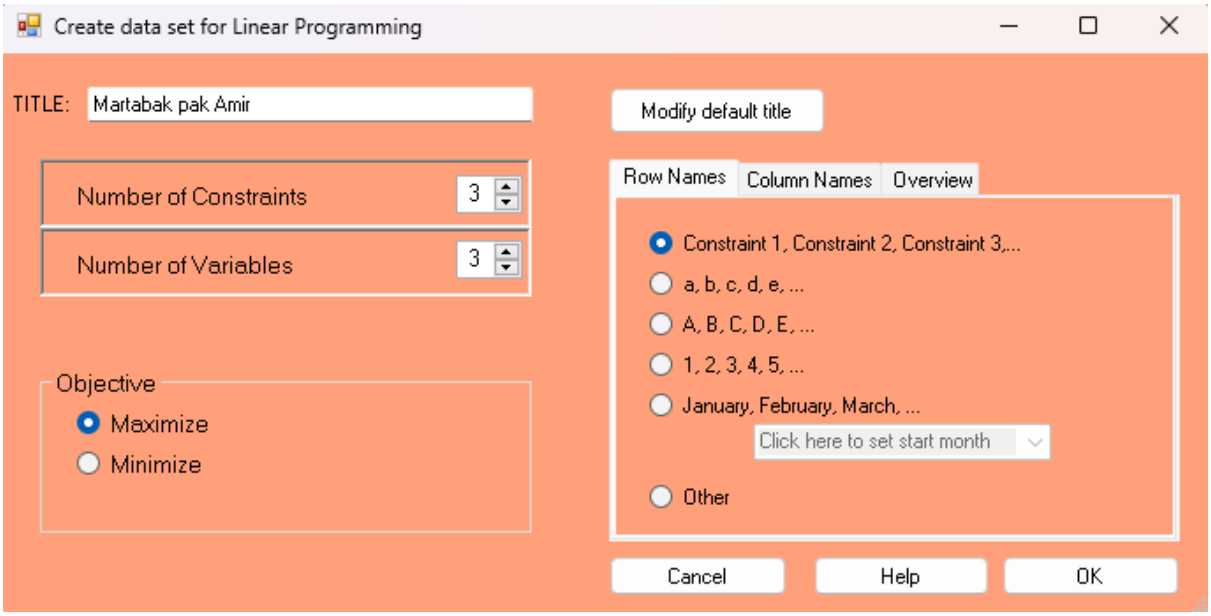
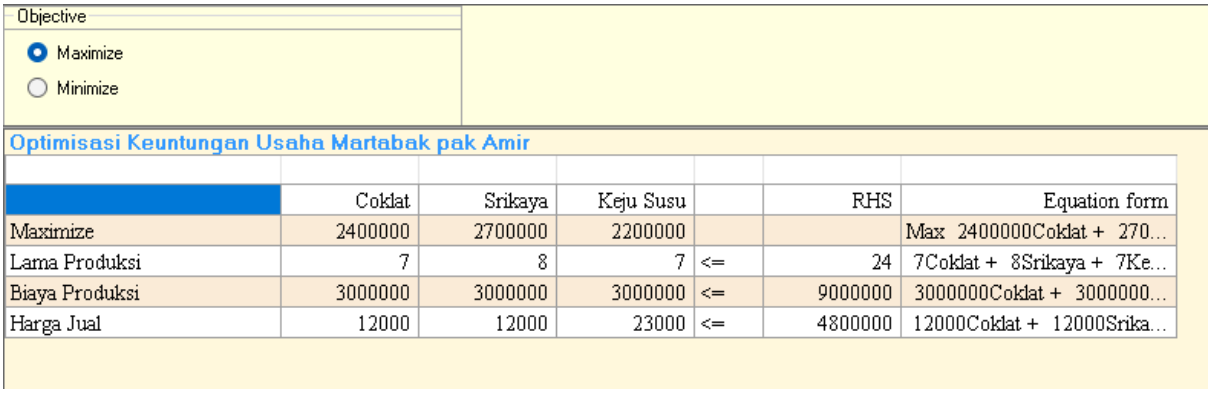


Figure 4. Data FLP



	Coklat	Srikaya	Keju Susu		RHS	Equation form
Maximize	2400000	2700000	2200000			Max 2400000Coklat + 270...
Lama Produksi	7	8	7	<=	24	7Coklat + 8Srikaya + 7Ke...
Biaya Produksi	3000000	3000000	3000000	<=	9000000	3000000Coklat + 3000000...
Harga Jual	12000	12000	23000	<=	4800000	12000Coklat + 12000Srika...

Source: processed by the author

Figure 5. Calculation Results

Optimisasi Keuntungan Usaha Martabak pak Amir Solution

Cj	Basic Variables	Quantity	2400000 Coklat	2700000 Srikaya	2200000 Keju Susu	0 slack 1	0 slack 2	0 slack 3
Iteration 1								
0	slack 1	24	7	8	7	1	0	0
0	slack 2	9,000,000	3,000,000	3,000,000	3,000,000	0	1	0
0	slack 3	4,800,000	12,000	12,000	23,000	0	0	1
	zj	0	0	0	0	0	0	0
	cj-zj		2,400,000	2,700,000	2,200,000	0	0	0
Iteration 2								
2700000	Srikaya	3	0.875	1	0.875	0.125	0	0
0	slack 2	0	375,000	0	375,000	-375,000	1	0
0	slack 3	4,764,000	1,500	0	12,500	-1,500	0	1
	zj	8,100,000	2362500	2700000	2362500	337500	0	0
	cj-zj		37,500	0	-162,500	-337,500	0	0
Iteration 3								
2700000	Srikaya	3	0	1	0	1	0.0	0
2400000	Coklat	0	1	0	1	-1	0.0	0
0	slack 3	4,764,000	0	0	11,000	0	-0.004	1
	zj	8,100,000	2400000	2700000	2400000	300000	.1	0
	cj-zj		0	0	-200,000	-300,000	-0.1	0

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Source: processed by the author

REFRENCE

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