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Diet Package Profit Optimization of a Fitness Center Using the Simplex Method and POM-QM Software

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Abstract

The growing trend of healthy lifestyles has encouraged fitness centers to provide supporting services in the form of healthy meal packages tailored to customers' nutritional needs. This study aims to optimize the profit of diet package production at a fitness center using the simplex method and POM-QM software. The research employed a descriptive quantitative approach using secondary data consisting of profit per package, resource requirements, and available resource capacities. The study focused on two types of diet packages, namely the High-Protein Package and the Balanced Package, with limited resources of 500 kg of food ingredients, 2,000 hours of nutritionist consultation time, and 1,500 hours of kitchen capacity per month. The mathematical model was formulated into an objective function and constraint functions, then solved manually using the simplex method and validated using POM-QM for Windows software. The results showed that the optimal solution was achieved by producing 100 High-Protein Packages and no Balanced Packages. This combination generated a maximum profit of Rp25,000,000 per month. Both manual calculations and POM-QM software produced the same results, indicating that the simplex method is capable of providing accurate optimal solutions. In addition, the use of POM-QM software accelerated the analysis process, minimized calculation errors, and facilitated the visualization of optimization results. Therefore, the simplex method and POM-QM software are effective tools for decision-making in determining the optimal production strategy for diet packages at fitness centers.

***Keywords**: linear programming, simplex method, profit optimization, POM-QM, healthy diet packages.*

1. Introduction

In an era of increasingly fierce business competition, efficient and data-driven decision-making has become a primary necessity for business actors, including in the food and fitness sectors. Resource limitations such as raw materials, experts, and production capacity demand an appropriate planning strategy to maximize profit. One quantitative approach proven effective in solving this problem is linear programming, which is an optimization method used to find the best value of a linear objective function while considering various applicable constraints (Fikri et al., 2021). Linear programming has three main elements, namely decision variables, objective function, and constraint functions, which together form a mathematical model of a real-world problem.

Among various techniques in linear programming, the simplex method is the most widely used approach due to its ability to handle optimization problems with more than two variables and constraints. This method works iteratively through calculation tables to find the combination of variable values that produces the optimal solution (Susanti, 2021). Previous research proves that the simplex method successfully increased production profits in various types of food businesses, including tofu MSMEs, where the optimal solution was obtained through several simplex table iterations by considering raw material availability and daily production capacity (Susanti, 2021).

Along with technological developments, the application of the simplex method is now increasingly facilitated by the presence of specialized software such as POM-QM software. Tamiza et al. (2023) in their research on the optimization of martabak production profit concluded that the use of POM-QM is capable of producing solutions that are just as accurate as manual calculations, but with a much shorter time and smaller risk of error. A similar thing was also shown by Daryani et al. (2024) who applied a combination of the simplex method and POM-QM software to banana chips MSMEs, where a significant difference in profit was obtained between conditions before and after optimization, proving that this approach is highly relevant to be applied to small and medium-scale businesses.

Fitness centers are one type of business that is closely related to the provision of healthy food products, where production efficiency becomes a critical factor in maintaining business sustainability and profitability. With limited resources such as food ingredient stocks, nutritionist consultation time, and kitchen capacity, managers are demanded to determine the optimal production combination of diet packages. Arifai (2024) emphasizes that linear programming with the simplex method can be a reliable solution for small-scale food industries in determining the production quantity that provides maximum profit without violating existing resource limits. Based on this background, this study aims to apply the simplex method and POM-QM software to optimize the production profit of diet packages in a fitness center, as well as to compare the results of the two approaches.

2. Method

This study belongs to the descriptive quantitative research type. Quantitative research is research that uses quantitative data in the form of numbers as the basis in research to solve a problem in research. The quantitative research method is a research method based on the philosophy of positivism, used to examine specific populations or samples, data collection using research instruments, and data analysis is quantitative in nature (Azizah et al., 2023).

Data collection in this study was carried out through the literature review method (library research). Literature review is a data collection method by understanding and studying theories from various literatures related to the research. Data collection was carried out by searching for sources and constructing from various sources such as books, journals, and existing researches (Azizah et al., 2023). The data used in this study is secondary data from a fitness center, including profit per package, resource requirement per package (food ingredients, nutritionist consultation time, and kitchen capacity), and available resource capacity per month. Semantic Scholar

The data analysis technique used is the simplex method. The simplex method is a linear programming solution method with many variables and many QM constraints with iteration steps adjusted to the form of the objective and constraints as well as their results. The simplex method is one approach to solving linear programming problems that have two or more decision variables, where determining the optimal combination is carried out through repeated iterations of the simplex table until the optimum value is found in the optimization problem, which includes maximizing profits or minimizing costs (Azizah et al., 2023). The completion steps performed in this study are: (1) formulating a mathematical model in the form of an objective function and constraint functions, (2) converting constraints into equation forms by adding slack variables, (3) compiling the initial simplex table, (4) performing simplex table iterations until there are no negative values in the objective function row, and (5) validating the results using POM-QM software. This study uses the simplex method assisted by POM- for Windows software in searching for maximum profit, so it can be concluded that the simplex method is suitable for finding the optimum solution (Tamiza et al., 2023).

3. Results and Discussion

The growing public awareness of healthy living has encouraged fitness centers to not only provide exercise facilities but also offer healthy food services tailored to customers' nutritional needs. As part of this service, the fitness center provides two types of diet packages: the High-Protein Package, focused on supporting muscle development, and the Balanced Package, aimed at maintaining adequate daily nutrition. However, managers face difficulties in determining the optimal daily production quantity of each package due to limited resources, including food ingredient stock, nutritionist consultation time, and kitchen preparation capacity. The difference in resource requirements per package makes it necessary to apply a precise decision-making method to avoid inefficiency or losses from mismatched production.

To address this problem, a quantitative analysis method is required. Linear programming with the simplex method is used here to determine the best production combination of the High-Protein Package and the Balanced Package that yields maximum profit without exceeding available resource limits. Additionally, POM-QM software is used to accelerate the calculation process, improve efficiency, and minimize manual calculation errors.

The case details are as follows. A fitness center offers two types of diet packages: the High-Protein Package and the Balanced Package. Each month, the fitness center has the following resource constraints: 500 kg of food ingredients (meat, vegetables, and supplements), 2,000 hours of nutritionist consultation time, and 1,500 hours of kitchen capacity for food preparation.

Table 1. Resource Requirements per Package

Diet Package	Food Ingredients (kg)	Consultation Time (hours)	Preparation Time (hours)	Profit per Package (Rp)
High-Protein Package	5	8	6	250,000
Balanced Package	10	6	9	400,000

The objective is to determine the number of High-Protein Packages and Balanced Packages that should be produced each month to maximize total profit.

3.1. Manual solution using the simplex method

a. Formulating the mathematical model

Decision variables:

- x_1 = number of High-Protein Packages
- x_2 = number of Balanced Packages

Objective function: Maximize $Z = 250{,}000x_1 + 400{,}000x_2$

Constraint functions:

- $5x_1 + 10x_2 \leq 500$ (food ingredients)
- $8x_1 + 6x_2 \leq 2{,}000$ (consultation time)

- $6x_1 + 9x_2 \leq 1{,}500$ (kitchen capacity)
- $x_1, x_2 \geq 0$

b. Adding slack variables s_1, s_2, s_3 and converting to implicit form:

$$Z - 250{,}000x_1 - 400{,}000x_2 = 0 \quad 5x_1 + 10x_2 + s_1 = 500 \quad 8x_1 + 6x_2 + s_2 = 2{,}000 \quad 6x_1 + 9x_2 + s_3 = 1{,}500$$

Initial simplex table:

	X_1	X_2	S_1	S_2	S_3	RHS
Z	**-250,000**	**-400,000**	**0**	**0**	**0**	**0**
S_1	**5**	**10**	**1**	**0**	**0**	**500**
S_2	**8**	**6**	**0**	**1**	**0**	**2000**
S_3	**6**	**9**	**0**	**0**	**1**	**1,500**

Pivot column: x_2 (most negative value in Z row: −400,000). Pivot element: 10.

c. Determining the pivot row (minimum ratio test):

- $\frac{500}{10} = 50 \rightarrow$ pivot row
- $\frac{2{,}000}{6} = 333.33$
- $\frac{1{,}500}{9} = 166.67$

d. Iteration 1 New key row (x_2):

New x_2 row $= \frac{(5, 10, 1, 0, 0, 500)}{10} = (0.5, 1, 0.1, 0, 0, 50)$

Updated rows:

- New Z row = (-250,000, 0, 40,000, 0, 0, 20,000,000) - (-400,000) × new x_2 row
- New S_2 row = (5, 0, -0.6, 1, 0, 1,700)
- New S_3 row = (1.5, 0, -0.9, 0, 1, 1,050)

Simplex table after Iteration 1:

	X_1	X_2	S_1	S_2	S_3	RHS
Z	−50,000	0	40,000	0	0	20,000,000
X_2	$\frac{1}{2}$	1	0.1	0	0	0
S_2	5	0	$\frac{-3}{5}$	1	0	1,700
S_3	$\frac{3}{2}$	0	-0.9	0	1	1,050

Pivot column: x_1 (−50,000 is the most negative in Z row). Pivot element: 1/2.

e. Minimum ratio test for Iteration 2:

- $\frac{50}{0.5} = 100 \rightarrow$ pivot row (x_2 row)
- $\frac{1{,}700}{5} = 340$
- $\frac{1{,}050}{1.5} = 700$

f. Iteration 2 — New key row (x_1):

$$\text{New } x_1 \text{ row} = (1/2, 1, 0.1, 0, 0, 50) / (1/2) = (1, 2, 1/5, 0, 0, 100)$$

Updated rows:

- New Z row = (0, 100,000, 50,000, 0, 0, 25,000,000)
- New S_2 row = (0, -10, $\frac{-8}{5}$, 1, 0, 1,200)
- New S_3 row = (0, -3, $\frac{-6}{5}$, 0, 1, 900)

Final simplex table:

	X_1	X_2	S_1	S_2	S_3	RHS
Z	0	100,000	50,000	0	0	25,000,000
X_2	1	-2	$\frac{1}{5}$	0	0	100
S_2	0	-10	$\frac{-8}{5}$	1	0	1,200
S_3	0	-3	$\frac{-6}{5}$	0	1	900

Since all Z-row values are non-negative, the optimal solution is reached:

- $x_1 = 100$ (High − Protein Packages)
- $x_2 = 0$ (Balanced Packages)
- Maximum profit $Z = \mathbf{Rp25,000,000}$

Therefore, the fitness center should produce only 100 High-Protein Packages per month to achieve maximum profit of Rp25,000,000.

3.2. Validation using POM-QM software

The results were validated using POM-QM for Windows by selecting the Linear Programming module, creating a new project, and entering the objective function coefficients, constraint coefficients, and RHS values as follows:

1. POM-QM data entry for the linear programming model *(insert POM-QM data entry screenshot here)*

After clicking "Solve", the software produced the following results:

Linear Programming Result:

- $x_1 = 100, x_2 = 0$
- Maximum $Z = \text{Rp}25{,}000{,}000$

2. POM-QM linear programming result *(insert screenshot)*

Ranging: The ranging output shows the upper and lower bounds of each objective function coefficient within which the current optimal solution remains unchanged. For x_1 (Rp250,000), the lower bound is Rp200,000 and the upper bound is infinity.
For x_2 (Rp400,000), the lower bound is infinity and the upper bound is Rp500,000. This information is useful for decision-making when price or profit fluctuations occur.

3. POM-QM ranging output

Solution List: The slack variable values indicate that Constraint 1 (food ingredients) has a slack of 0, meaning this constraint is binding. Constraint 2 (consultation time) has a slack of 1,200 hours, and Constraint 3 (kitchen capacity) has a slack of 900 hours, both indicating unused resource capacity.

4. POM-QM solution list

Iterations: POM-QM displays the simplex tableau for each iteration, confirming that the optimal solution was reached when all (Cj − Zj) values became ≤ 0, consistent with the manual calculation.

5. POM-QM iteration tables

Dual Problem: The dual output shows that the resource limits (500, 2,000, 1,500) become objective function coefficients in the dual problem, while the original coefficients become constraints. This helps identify which resource contributes most to the total profit in this case, the food ingredient constraint ($\text{dual value} = 50{,}000$) is the only binding constraint with a positive shadow price.

6. POM-QM dual problem output

Graph: The feasible region graph confirms that the optimal point lies at $x_2 = 0$ and $x_1 = 100$.

7. POM-QM feasible region graph

Based on both the manual simplex method and POM-QM software, the same optimal solution is confirmed: $x_1 = 100, x_2 = 0$, with a maximum profit of Rp25,000,000. This demonstrates that the simplex method provides accurate results whether solved manually or by software. POM-QM offers additional advantages in speed and result visualization, while the manual approach remains valuable for deepening understanding of the calculation process.

4. Conclusion

Based on the results of this study, the simplex method can be used effectively to determine the optimal production combination of diet packages that yields maximum profit at a fitness center while respecting existing resource constraints. The calculation results show that the optimal solution is to produce 100 High-Protein Packages and zero Balanced Packages per month, generating a maximum profit of Rp25,000,000. Both the manual simplex calculation and the POM-QM software validation produced identical results, confirming that POM-QM assists in solving the problem more quickly, accurately, and efficiently. Therefore, the simplex method combined with POM-QM software can serve as an effective decision-making tool for production planning in resource-constrained businesses. Future research is recommended to develop models incorporating more product variables and constraints to produce more complex analyses that better reflect real-world conditions.

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