# SIMPLEX METHOD FOR PROFIT MAXIMIZATION IN CHINESE BREAKFAST FOOD STALL 

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#### Abstract

Linear programming is an operational research technique widely used to identify action solutions for managers. The linear programming model explores the efficient use of available raw materials to produce different marketable products. Linear programming will encourage companies to increase production by taking full advantage of this opportunity. However, the trial-and-error approach is most often used by many organizations. As a result, firms find it challenging to allocate scarce resources in a profit-maximizing manner. This study focuses on implementing optimization principles to optimize manufacturing revenues through linear programming to measure production costs and determine their optimal benefits. The study uses data from Chinese food stall reports for five breakfast types: nasi lemak, fritters, curry puff, ear-eye cake, and popiah. The attribute has been identified as a linear programming problem, built mathematically and solved using Excel software. The results show that the food stall should concentrate more on producing curry puff and popiah. In comparison, other products should be produced less because their value becomes zero to reach the maximum monthly profit of RM28, 236. The analysis found that curry puff and popiah objectively contribute to the revenue. Therefore, more curry puff and popiah must be produced and sold to maximize profit.


Keywords: linear programming, optimization problem, simplex method, operational research, food stall.

## 1. INTRODUCTION

Every organization or company must earn a profit to maintain its continued existence and competitiveness. The key branch of every economy is the food industry, which is at the centre of agricultural ingredients and food supply production. The food stall is a business that is found throughout each state of Malaysia. Every generation loves food. Part of the reason is its high carbon content, which can lead to an energy supply. Other nutrients, such as proteins, carbs, and minerals, are also found in stall breakfast.

Linear programming is a mathematical process used to evaluate the best blend of products to maximize advantages or minimize costs. Linear programming is often used to choose the right solution for many problems, such as the division of funds, responsibilities, and materials. On the contrary, linear programming works to select the best course of action among many alternatives [1]. Linear programming is a term that encompasses mathematical techniques directed at optimizing results by combining resources.

Linear programming models discuss the efficient use of available raw materials to manufacture various commercial products [2]. Therefore, it is necessary to minimize production costs to increase sales by converting raw materials into finished products [3]. This problem is summarized as estimating the quantity of each raw material to minimize the production cost and maximize the profit. Furthermore, this process will help the company improve its products based on the recommendations made by linear programming results.

## 2. LITERATURE REVIEW

Linear programming is a strategy that requires minimizing or optimizing a given quantity [4]. Nowadays,
linear programming is used in various fields because it has many real-life applications [5]. For example, operations research is a discipline consisting of analytical methods to assist in making better decisions. Operations research has been applied in many logistics, finance, and transportation industries. For some applications to aircraft routing, see, for example, [6]. Miller [7] claims that linear programming is used to effectively model various real-life problems, from routing airlines to transporting oil from refineries to towns, by finding the minimum cost to achieve the minimum standard required. In addition, there are many techniques for improving decision-making, such as optimization, neural networks, and queuing theory. For some discussion on neural networks, see [8].

Oluwaseyi et al. [9] proposed a linear programming approach to decision-making at the Benin Bread University in Benin District, Edo State, Nigeria. Oluwaseyi et al. [9] wanted to specify the number of loaves of bread that can be manufactured in a day at the Benin Bakery to maximize profit according to the constraints of the manufacturing process. The problem was formulated in mathematical terms and solved using a linear programming solver (LIPS). The solutions collected from one iteration showed that the baker must produce 667 large loaves per day to achieve the maximum daily profit of $£ 100,000$. Therefore, Oluwaseyi et al. suggested that the Benin bakery focus more on making large loaves to achieve the maximum yield of $£ 100,000$ per day.

Saoji et al. [10] used the Simplex algorithm to allocate raw materials among bakeries with competing products (bread, cookies, cakes, and macarons) to maximize profits. The results obtained from the analysis showed that the baker should produce 103 units of bread, 368 units of cake, 42 units of macarons, and no cookies to earn Rs. 324,488. From the analysis, it is clear that cakes,
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bread, and macarons contribute more to the profit. Therefore, cakes need to be produced in larger quantities than other products to maximize profits.

Ailobhio et al. [11] analyzed the optimal solution for the lace baking industry in Lafia, Nigeria. The problem was formulated in a linear programming approach and solved using R statistical software. The results indicated that the baker should produce 1,550 family loaves and 4,650 mini loaves for the lace baking industry to achieve the maximum monthly profit of $£ 558,000$. Furthermore, Ailobhio et al. reported that the mini loaves and family loaves would yield the best profit. However, more mini bread and family bread need to be developed and marketed to maximize profits.

Oladejo et al. [12] applied the linear programming problem to secondary data collected from Landmark University bakery records. The results obtained from AMPL software showed that Landmark bakery should concentrate more on producing 14,000 family loaves and 10,571 chocolate loaves to achieve a maximum monthly profit of $¥ 1,860,000$.

Abiodun and Clement [13] used a linear programming technique to study the implementation of bread production in Rufus Giwa Polytechnic Bakery, Owo, Ondo State, Nigeria. Abiodun and Clement [13] collected data for four weeks based on the processing temperature per unit of bread using a pocket infrared thermometer to assess whether there would be some variation in the activity pattern. However, it proved to be the same as the repetitive manufacturing process accompanying the program. Abiodun and Clement [13] evaluated the data using LINGO software; the results showed that the optimal solution obtained by linear programming was $47,572.28$. Therefore, the results recommended that the institutional bakery use only 1.175 units (i.e., one bag of flour) per day to produce 235 extralarge loaves per day to maximize the profit of $¥ 47,572.28$ for the Rufus Giwa Polytechnic bakery.

Akpan and Ojoh [14] pointed out that Karmarkar's algorithm is not so popular in solving linear programming problems because there are many variables in linear programming problems. Akpan and Ojoh used Scilab 5.5.2 software for the Karmar method and Tora software for the Simplex method to study six coca-cola Hellenic Port Harcourt plants and compared the results. The Karmarkar algorithm produced a maximum profit of N70, 478, 116.00. On the other hand, the Simplex method made a maximum profit of N107, 666, 639.51 and only required about 339,482 cases of Schweppes 33 cl from the available capital to get the best solution.

Ghosh et al. [15] developed a linear programming model to reduce the complexity of the scheduling problem in the pursuit of profit maximization in the composite textile industry. The model was developed considering the
division of processes, machine utilization, and other resources for lead times. Four different lead-time components were derived, and a Microsoft Excel solver was used to solve the model. As a result, Ghosh et al. [15] found that the maximum profit was $\$ 5,164$ and that the composite textile industry would obtain this maximum profit if the project were completed within 31 days.

## 3. RESEARCH METHOD

The data obtained for this project came from an anonymous Chinese food stall in AlorSetar, Kedah. The food stall created a strategically important management judgment by making five different breakfast varieties that determined changing the number of goods produced in the product mix. The study used linear programming to evaluate the new mix quantities. As a result, the cumulative profit contribution of each service in the first quantity of the month is now linked to the incremental profit contribution generated by the previous mix of products, which was calculated using a trial-and-error approach [15].

Linear programming needs to be displayed in a general standard type. Linear programming involves a linear objective function, $Z$, such that, if in general $c_{1}, c_{2}, \ldots, c_{n}$ are real numbers, then the function of real variables $x_{1}, x_{2}, \ldots, x_{n}$ can be defined as:
$Z=\max \sum_{j=1}^{5} c_{j} x_{j}$.
The objective function is subject to
$\sum_{\mathrm{j}=1}^{5} \mathrm{a}_{\mathrm{ij}} \mathrm{x}_{\mathrm{j}} \leq \mathrm{b}_{\mathrm{i}}, \mathrm{i}=1,2,3,4,5,6,7 . \mathrm{x}_{\mathrm{j}} \geq 0, \mathrm{j}=1,2,3,4,5 . \quad$ (2) where,
$Z \quad$ represents the value of the objective function.
$c_{j} \quad$ is the coefficients, represent the marginal change in the value of the objective function Z .
$x_{j} \quad$ is the decision variables that decide on each resource, either to use or remove in the optimal formulation.
$a_{i j} \quad$ is the coefficient that indicates the number of resources.
$b_{i} \quad$ is the variables represent the initial quantity of resources.

## 4. RESULTS AND DISCUSSIONS

In this section, the database for this analysis was obtained from the food stall in Alor Setar. The data collected focused on the breakfast varieties for one month. The collected data concentrates on the actual contents used in breakfast production. The content produced per breakfast is shown below.

Table-1. Breakfast produced by food stall.

| Name of product | Production cost per item <br> (cent) | Selling price per item <br> (cent) | Profit (cent) |
| :---: | :---: | :---: | :---: |
| NasiLemak $\left(x_{1}\right)$ | 80 | 150 | 70 |
| Fritters $\left(x_{2}\right)$ | 60 | 120 | 60 |
| Curry Puff $\left(x_{3}\right)$ | 70 | 150 | 80 |
| Ear Eye Cake $\left(x_{4}\right)$ | 50 | 120 | 70 |
| Popiah $\left(x_{5}\right)$ | 70 | 130 | 60 |

Table-2. Quantities of raw materials for each breakfast item production.

| Raw materials | Types of bread and their ingredient combinations |  |  |  | Total quantity per <br> month (gram) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\boldsymbol{x}_{\mathbf{1}}$ | $\boldsymbol{x}_{\mathbf{2}}$ | $\boldsymbol{x}_{\mathbf{3}}$ | $\boldsymbol{x}_{\mathbf{4}}$ |  | (g) |
| Flour | 300 | 300 | 270 | 380 | 320 | 128500 |
| Potato | 8 | 10 | 7 | 9 | 7 | 60000 |
| Anchovy | 60 | 55 | 70 | 80 | 50 | 24000 |
| Egg | 50 | 40 | 60 | 30 | 55 | 36500 |
| Rice | 50 | 60 | 65 | 80 | 70 | 90000 |
| Turnip | 74 | 72 | 78 | 84 | 76 | 98000 |
| Sugar | 60 | 60 | 38 | 40 | 30 | 27500 |

As seen below, we added objective function and constraint values in the linear programming model.
Maximize $z=70 x_{1}+60 x_{2}+80 x_{3}+70 x_{4}+60 x_{5}$.
Subject to:
Flour: $300 x_{1}+300 x_{2}+270 x_{3}+380 x_{4}+320 x_{5}$

$$
\leq 128500
$$

Potato: $8 x_{1}+10 x_{2}+7 x_{3}+9 x_{4}+7 x_{5} \leq 60000$,
Anchovy: $60 x_{1}+55 x_{2}+70 x_{3}+80 x_{4}+50 x_{5}$

$$
\leq 24000
$$

Egg: $50 x_{1}+40 x_{2}+60 x_{3}+30 x_{4}+55 x_{5} \leq 36500$,
Rice: $50 x_{1}+60 x_{2}+65 x_{3}+80 x_{4}+70 x_{5} \leq 90000$,
Turnip: $74 x_{1}+72 x_{2}+78 x_{3}+84 x_{4}+76 x_{5} \leq 98000$,
Sugar: $60 x_{1}+60 x_{2}+38 x_{3}+40 x_{4}+30 x_{5} \leq 27500$,
$\mathrm{x}_{1}, \mathrm{x}_{2}, \mathrm{x}_{3}, \mathrm{x}_{4}, \mathrm{x}_{5} \geq 0$.

### 4.1 Analysis of Excel's Solver

The above data is analyzed using Excel's Solver for the Simplex method, and the result is as below:

Table-3. Result answer report for the objective cells using excel's solver.

| Cell | Name | Original <br> Value | Final <br> Value |
| :---: | :---: | :---: | :---: |
| J6 | objective <br> function, $z$ | 0 | 28236 |

Table-4. Result answer report for the variable cells using excel's solver.

| Cell | Name | Original <br> Value | Final <br> Value |
| :---: | :---: | :---: | :---: |
| E4 | optimal <br> value $x_{1}$ | 50 | 0 |
| F4 | optimal <br> value $x_{2}$ | 50 | 0 |
| G4 | optimal <br> value $x_{3}$ | 50 | 141 |
| H4 | optimal <br> value $x_{4}$ | 50 | 0 |
| I4 | optimal <br> value $x_{5}$ | 50 | 283 |

Table-5. Result answer report for constraint using excel's solver.

| Cell | Name | Cell Value | Formula | Status | Slack |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 10 | $\operatorname{egg} z$ | 36197.18 | $50 x_{1}+40 x_{2}+60 x_{3}+30 x_{4}+55 x_{5} \leq 36500$ | Not <br> Binding | 12497.19 |
| 11 | Rice $z$ | 89892.96 | $50 x_{1}+60 x_{2}+65 x_{3}+80 x_{4}+70 x_{5} \leq 90000$ | Not <br> Binding | 61053.37 |
| 12 | Turnip $z$ | 15444.51 | $74 x_{1}+72 x_{2}+78 x_{3}+84 x_{4}+76 x_{5} \leq 98000$ | Not <br> Binding | 65524.72 |
| 13 | sugar $z$ | 27359.99 | $60 x_{1}+60 x_{2}+38 x_{3}+40 x_{4}+30 x_{5} \leq 27500$ | Not <br> Binding | 13664.04 |
| 7 | flour $z$ | 152484.51 | $300 x_{1}+300 x_{2}+270 x_{3}+380 x_{4}+320 x_{5}$ <br> $\leq 128500$ | Binding | 0.00 |
| 8 | Potatoz | 5082.82 | $8 x_{1}+10 x_{2}+7 x_{3}+9 x_{4}+7 x_{5} \leq 60000$ | Not <br> $\leq 6500$ | 57034.83 |
| 9 | Anchovy $z$ | 13799.99 | $60 x_{1}+55 x_{2}+70 x_{3}+80 x_{4}+50 x_{5} \leq 24000$ | Binding | Bing |

### 4.2 Analysis of Results

Using the Simplex approach, the Excel Solver analysis results on the Linear Programming model determined the objective function's value to be RM28236. The inputs to the objective function of the five variables $x_{1}, x_{2}, x_{3}, x_{4}, x_{5}$ are $0,0,141,0$, and 283 . The result reveals that only $x_{3}$ and $x_{5}$ variables contributed significantly to improving the objective function at 141 and 283 , respectively. Based on the implications of the linear programming model, the focus on the production of $x_{3}$ (Curry Puff) and $x_{5}$ (Popiah) is optimal and profitable for a food stall. The result will support the food stall optimally from the expense of raw materials, and the maximum profit is about RM28236 per month.

## 5. CONCLUSIONS

This model analyzed five different bread varieties produced by the breakfast food stall using Excel's solver in this project. Based on the analysis results, we recommended that the stall focuses on the production of the curry puff and popiah, depending on the raw materials available each month. The results indicated that stall owners should focus more on the production of curry puff and popiah. Other types of products should be produced less because their value is zero to achieve the maximum profit of RM28236. The linear planning also shows that curry puff and popiah contribute to the highest and maximum profit. Therefore, the stall needs to produce and sell more curry puff and popiah.

The limitations of this study should be recognized when analyzing the results and conducting further research to maximize profits. For example, stall owners should consider other factors influencing sales instead of focusing on raw materials to maximize profits, such as marketing strategies, advertising, location, and price. This analysis model currently conducted is in a town in AlorSetar, Kedah. To expand this analysis, researchers should include other cities and towns to present a more representative overview of the factors influencing consumer spending on breakfast purchases.

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