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Integer Programming Application to Optimize Profit of Samarinda Special Souvenir Production

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ABSTRACT

Yulia's Amplang shop is one of the businesses engaged in the culinary field in the form of souvenirs typical of Samarinda City, namely Amplang. The amplang variants produced by this store include flat fish (original), shrimp, crab, squid and seaweed. Limitations and rising raw material prices make stores often experience difficulties in optimizing production profits. This study aims to determine the number of packages in one production process for each variant produced so as to obtain maximum profit. This study used the revised simplex method and then continued with the Branch and Bound Method, which is a method used to solve linear programming problems that produce solutions in integer form. From the analysis using this method, the optimal amount was obtained as many as 317 packages per production, including 144 flat fish flavors (original), 52 shrimp flavors, 34 crab flavors, 54 squid flavors and 33 seaweed flavors with the maximum profit obtained. namely Rp. 4,125,635. The application of this method resulted in an increase in profits of 5.53% or Rp. 216,103 in one production process compared to the previous company's profits.

I. Introduction

Operations research is an approach to decision making characterized by the use of scientific knowledge through interdisciplinary group efforts aimed at determining the best use of limited resources [1]. There are many things around us where we want to find the optimum value, such as maximum profit, minimum cost, and so on. These things become the basis for the emergence of optimization problems, namely a process to achieve ideal or optimal results (effective values that can be achieved). In the mathematical discipline, optimization refers to the study of problems that try to find the minimum or maximum value of a real function [2].

In general, a company wants to get maximum income with minimum expenses in order to increase company profits. This is also done by Toko Amplang Yulia, which is engaged in the culinary business in the form of souvenirs typical of Samarinda. This company produces several types of flavors such as flat fish (original), shrimp, squid, crab and seaweed. The problem faced by the company is an optimization problem where it is difficult to determine the amount of Amplang packaging production to maximize profits with the constraints of limited raw materials in one production process, and no raw materials left.

Based on the background described above, the authors are interested in conducting research with the title "Applications of Integer Programming for Optimizing Profits in the Production of Typical Samarinda Souvenirs (Case Study: Production of Amplang Yulia Samarinda Shop)**.**

II. Method

The research conducted is research that aims to explain the causal relationship (causality) between one variable and another (variable X and variable Y). In order to explain this causality relationship, the researcher must exercise very careful control and measurement of the research variables. This

research was conducted in May - November 2022. Data collection was carried out in July at the Amplang Yulia Samarinda Store located on Jalan Slamet Riyadi No. 16, Teluk Lerong Ulu Village, Sungai Kunjang District, Samarinda City, East Kalimantan. Data processing was carried out at the Computational Mathematics Laboratory, Faculty of Mathematics and Natural Sciences, Mulawarman University. There are two data collection instruments used in this study, namely literature studies and direct interviews with related parties. The data obtained from the two instruments will form a problem model of the objective function and constraint function, then calculate the value of the decision variable using the revised simplex method linear program to obtain optimal results, afterwards to obtain results in the form of integers integer programming will be carried out using the Branch and Bound method.

The research carried out is research that aims to explain the cause-and-effect relationship (causality) between one variable and another (variable X and variable Y). To explain this causal relationship, researchers must carry out very careful control and measurement of the research variables [3].

In this study the sampling method or sampling technique used was purposive sampling. The main feature of this sampling is that sample members are specifically selected based on research objectives [4]. With drawal of sample data based on the availability of the latest data from the company.

The steps to analyze the data are as follows:

A. The collection of data needed in this study includes:
   a. Data on the types of Amplang flavor variants produced
   b. Data on raw materials for the production of Amplang
   c. Data on the amount of raw material inventory in one production process.
   d. Production cost data and Amplang profit.
   e. Data on the number of Amplang production
B. The data is formulated into a linear programming model

   According to [5], the general equation model for linear programming is as follows:

$$Z = \sum_{j=1}^{n} c_j x_j$$

   with constraints:

$$\sum_{j=1}^{n} a_{ij} x_j \leq atau \geq b_i$$

   For $x_j \geq 0$ and $i = 1,2,3, \dots n$

C. Completion of the model is solved using the revised simplex meth

   Linear programming problems in standard form can be expressed in matrix form as follows:
   Maximize or minimize:

$$Z = CX$$

   with constraints:

$$(A, I)X = b$$

D. Completion of optimum results into integer form using the Branch and Bound method

   The Branch and Bound algorithm systematically ignore a set of non-potential candidate solutions towards an optimal solution using upper and lower estimated bounds of the quantity being optimized. The Branch and Bound algorithm have three basic steps for each iteration, namely branching, bounding and fathoming or pruning [6].
E. From the settlement results using the Branch and Bound method, the optimum amount of production for each type of Amplang is obtained and the maximum total profit.
F. Comparing the profits obtained using the Branch and Bound method with the previous company's profits.

III. Results and Discussion

Table. 1. Amplang Raw Material on pack (Kg)

No	Raw materials used	The flavour				
		Flatfish	**Shrimp**	**Crab**	**Squid**	**Seaweed**
1.	Starch	0.4604	0.4604	0.4604	0.4604	0.4604
2.	Egg	0.0184	0.0184	0.0184	0.0184	0.0184
3.	Oil	0.3683	0.3683	0.3683	0.3683	0.3683
4.	Flatfish	0.5533	0	0	0	0
5.	Shrimp	0	0.5682	0	0	0
6.	Crab	0	0	0.5882	0	0
7.	Squid	0	0	0	0.5556	0
8.	Seaweed	0	0	0	0	0.6024

Table. 2. Amplang Raw Material Inventory in one production (Kg)

No	Raw materials used	Supply
1	Starch	150
2	Egg	6
3	Oil	120
4	Flatfish	80
5	Shrimp	30
6	Crab	20
7	Squid	30
8	Seaweed	20

Table. 3. Amplang production cost and profit (Rp)

No	Taste of Amplang	Production cost	Selling price	Profit
1	Flatfish	6303	20000	13697
2	Shrimp	7844	20000	12156
3	Crab	8425	20000	11575
4	Squid	7016	20000	12984
5	Seaweed	7078	20000	12922

Table. 4. Number of Amplang Packs

No	Taste of Amplang	Production amount
1	Flatfish	140
2	Shrimp	50
3	Crab	30
4	Squid	50
5	Seaweed	30

Data processing was carried out using two methods, namely the revised simplex method to find out the optimal amount of production, then followed by the Branch and Bound method to find the amount of production in integer form. The first is the simplex method. Based on the results of the iterations that have been carried out, it is obtained $x_1 = 144.6; x_2 = 52.8; x_3 = 34; x_4 = 54; x_5 = 33.2$. From this solution, 144.6 packs of flat fish flavor, 52.8 packs of prawn flavor, 34 packs of crab flavor, 54 packs of squid flavor and 33.2 packs of seaweed flavor need to be produced. However, this solution is not the right solution to use, because the production of Amplangs is produced in packaged form so that a round amount is needed. So we need a solution that is an integer number. Once known, it will be continued using the Branch and Bound Method to find a solution in the form of an integer.

The completion results of the Branch and Bound Method can be described in the form of a branching tree of the Branch and Bound Method which can be seen in the following Figure 1.

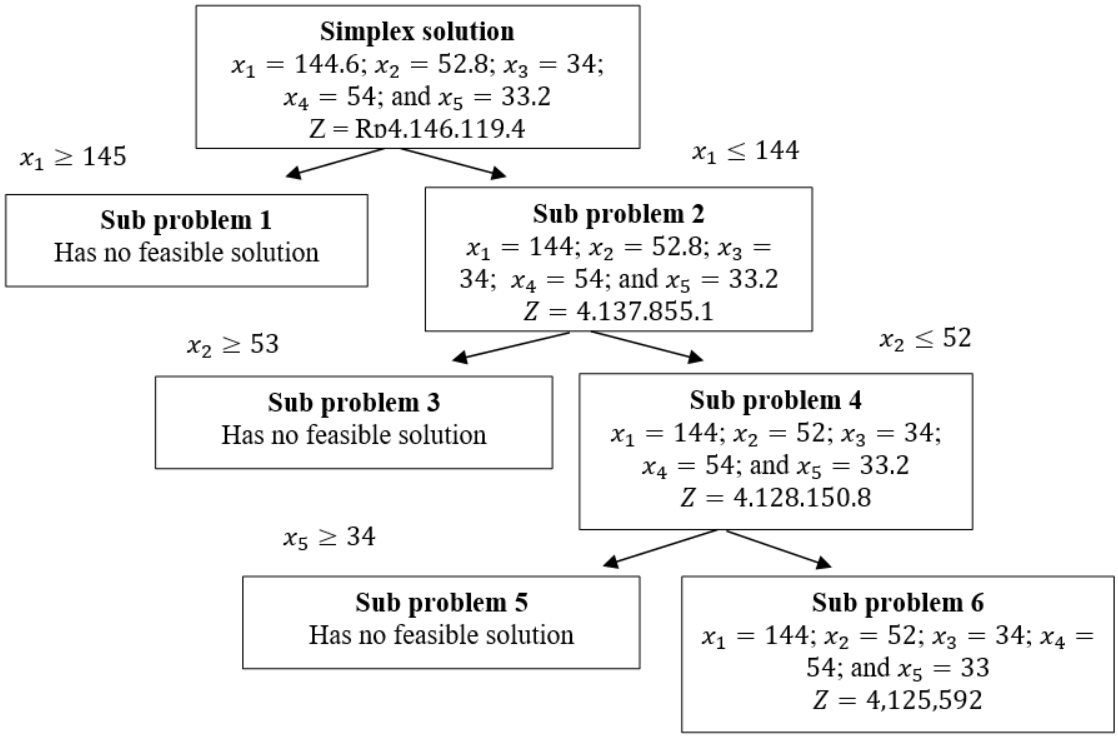

Fig. 1. Branching tree of the Branch and Bound Method

Based on the results of the calculations that have been carried out, a comparison of the company's production profits with the calculation of profits using the Branch and Bound Method is obtained as follows:

Table. 5. Comparison of Production Profits

No.	Variants of Amplang flavors	produced by the Company's		Branch and Bound Method	
		Total Production (Packaging)	Profit (Rp)	Total Production (Packaging)	Profit (Rp)
1.	Flatfish	140	1.917.642	144	1.972431
2.	Shrimp	50	607.783	52	632.095
3.	Crab	30	347.249	34	393.548
4.	Squid	50	649.213	54	701.150
5.	Flatfish	30	387.645	33	426.410
	Total	300	3.909.490	317	4.125.592

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