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Optimization maximum profit of production of rayon fabric using karush khun tucker method

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Abstract. The purpose of this research is to get the maximum benefit from rayon fabric production at Amir Sentosa - Bali Garment. Type of production in the form of beach wear, beach cloth, bed sheet, and Mukena. The manufacturing process of this type of production takes different times and length of materials. Function objective is formed from the profit per unit of production type taking by the distributor, while the constraint is obtained from the time of manufacture per unit and the length of material per unit required. One-year data is divided into three quarters, so each quarter receives a different amount of time during working day. The data is processed using Karush Khun Tucker method. The result show that the fabric are able to produce 400 units for each of the beach wear, beach cloth and bed sheet, while Mukena can be produced at 4853 units with maximum profit of IDR 16,560,000 in the third quarters, this is mean that if the working hours are added, it will followed by the increasing number of production quantity.

1. Introduction

Production optimization is required by the company in order to optimize the resources used for produce product in the expected quantity and good quality, so that the company can achieve its goals [1]. According to Bronson [2] optimization techniques can be used to complete the function of constrained and non-constrained functions. A crucial element in the optimization problem is the objective function, which depends on a number of input variables. These variables can be interdependent or not interdependent through one or more constraints.

Optimization can be done in two ways, namely maximization and minimization. Maximization is the optimization of production by using or allocating existing inputs to maximize profits, while minimization is the optimization of production to produce a certain level of output using input or the least cost [1].

One of the industries with high demand at this time is the cloth manufacturing industry. The large number of tourists in Bali make demands to produce cloth with Balinese motif are higher, especially using rayon material that become typical gift when they visiting Bali that has its own characteristics.

The company have to make production strategy to gain maximum profit. One method that can determine the maximum benefit with its obstacle is the Karush-Kuhn-Tucker (KKT) method. This method is use to determine the extreme value of a function, whether the maximum or minimum value of a function. In a function there are constraints that must be met to achieve optimal value.



Another study was conducted by Putra [2] on optimizing the sale of endek cloths by comparing two stores using the Karush-Kuhn-Tucker method with quarterly constraints. Therefore, researchers interest in conducting a research that apply The Karush Kuhn Tucker method in optimizing the production of Balinese motif rayon cloth on Amir Sentosa Garment. Amir Sentosa Garment is a company that produces balinese motifs rayon cloth in the form of beach wear, beach cloth, bed sheet, and Mukena.

2. Methods

The data used in this research is secondary data taken from month-ly period production record during January until December 2015 in Amir Sentosa Garment. The type of data used is quantitative data. There are 4 variables used in this research: the number of beach wear produced every day (x_1), the number of beach cloth produced every day (x_2), the number of bed sheet produced every day (x_3), the number of Mukena produced every day (x_4).

The steps of data analysis using Karush Kuhn Tucker method are as follows:

1. Collecting data of garment production quantities for the period January to December 2015.
2. Modeling the profit optimization problem on the sales of garment products based on their type into the form of Karush Kuhn Tucker method.
3. Determining the objective function of this problem that formed from the equation below.

$$f(X) = K_1x_1 + K_2x_2 + K_3x_3 + K_4x_4 \quad (1)$$

4. Determining the boundary function for the material obtained from the meter/pcs product type.

$$G_j(X) = b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 \leq \sum b_i \quad (2)$$

The form of the boundary function for an hour unit is obtained from the hour/pcs of product type.

$$G_j(X) = w_1x_1 + w_2x_2 + w_3x_3 + w_4x_4 \leq \sum w_i \quad (3)$$

Constraints for all materials (m^z) and time (hours)

$$\begin{aligned} x_1 &\geq 0 & x_3 &\geq 0 \\ x_2 &\geq 0 & x_4 &\geq 0 \end{aligned} \quad (4)$$

5. Completing the optimization problem with Karush-Kuhn- Tucker method to get the value of X^* dan λ^* , and determining the optimal value of $f(X)$, resulting in maximum production profit.

3. Results and discussion

The data used in this study is the type of product, the length of materials required, the price of material per meter, the cost of materials, and the selling price of the product. In this study, determining variables related to the number of products produce stated as follows x_1 is the number of products in type 1 (beach wear) produced in one day; x_2 is the number of products in type 2 (beach cloth) produced in one day; x_3 is the number of product in types 3 (bed sheet) produced in one day; and x_4 is the number of products in type 4 (Mukena) produced in one day. Use of such materials is limited as follows:

The steps of data analysis using Karush Kuhn Tucker method are as follows:

$$G_j(X) = b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 \leq R$$

$b_i x_i$ is the length of every materials used in making the product type i, R is materials inventory within 4 months.

The materials used to produce the products are in form of roll, which one roll length is 90 meters. Material inventory in the first quarter was 300 rolls or 27,000 meters, the second quarter was 250 rolls or 22,500 meters, and the third quarter was 270 rolls or 24,300 meters.

To make a piece beach wear (x_1) and requires 2 meters of materials, beach cloth (x_2) also require 2 meters of material, bed sheet (x_3) need 3.6 meters of material, and Mukena (x_4) need 3.4 meters of material.

The limiting function of materials usage as follows:

1. Quarter I : $2x_1 + 2x_2 + 3,6x_3 + 3,4x_4 \leq 27000$
2. Quarter II : $2x_1 + 2x_2 + 3,6x_3 + 3,4x_4 \leq 22500$
3. Quarter III : $2x_1 + 2x_2 + 3,6x_3 + 3,4x_4 \leq 24300$

The time needed for each product is beach wear (x_1) takes 10 minutes per piece, beach cloth (x_2) takes 13 minutes per piece, bed sheets (x_3) takes 15 minutes per piece, and Mukena (x_4) takes 12 minutes per piece with time availability 172800 minutes, then the time limiting function can be written as:

1. Quarter I : $10x_1 + 13x_2 + 15x_3 + 12x_4 \leq 70560$
2. Quarter II : $10x_1 + 13x_2 + 15x_3 + 12x_4 \leq 69840$
3. Quarter III : $10x_1 + 13x_2 + 15x_3 + 12x_4 \leq 73440$

The goal to be achieved by the company is to obtain maximum benefits of each type of the product. This can be obtained from the difference between the selling price of the product and the cost of the company. The data obtained from Amir Sentosa Garment mention that a pieces of beach wear (x_1) need 2 meters material, which has a store selling price of IDR 20,000 while the cost of good sold is IDR 18,000 so the profit is IDR 2,000 per pcs. A piece of beach cloth (x_2) also require 2 meters material, which has a selling price of IDR 25,000 and the cost of good sold is Rp23.000 so the profit is IDR 2,000 per pieces. Furthermore, for a pieces of bed sheets (x_3) require 3.6 meters materials that has a selling price of IDR 59,000, and the cost of good sold is IDR 58,000 so the profit is IDR 1,000 per pcs, while for a pieces of Mukena (x_4) requires 3.4 meters material with a shop selling price of IDR 49,000 and the cost of good sold is IDR 46.000 then get profit IDR 3,000 per pcs. So as to obtain the objective function as follows

$$f(X) = 2000x_1 + 2000x_2 + 1000x_3 + 3000x_4$$

The steps to calculate the optimal value by Karush Kuhn Tucker method are as follows:

Determining the Optimum Value of the First Quarter

Based on the limitations and objectives function that have been prepared, will be calculated the optimal value (maximize) of the model that is formed

$$f(X) = 2000x_1 + 2000x_2 + 1000x_3 + 3000x_4$$

With constraints:

$$2x_1 + 2x_2 + 3,6x_3 + 3,4x_4 \leq 27000$$

$$10x_1 + 13x_2 + 15x_3 + 12x_4 \leq 70560$$

$$x_1, x_2, x_3, x_4 \geq 400$$

Maple software is used to simplify the calculation to find every of x value, the maximum profit can be obtained when the company able to sell beach wear 400 pcs, beach cloth 400 pcs, Mukena 400 pcs and bed sheet of 4613 pcs, and the maximum profit reached by the company is IDR 15,840,000.

Determining the Optimum Value in Quarter II

Data used in the second quarter are taken in May, June, July, and August.

$$f(X) = 2000x_1 + 2000x_2 + 1000x_3 + 3000x_4$$

With constraints:

$$2x_1 + 2x_2 + 3,6x_3 + 3,4x_4 \leq 22500$$

$$10x_1 + 13x_2 + 15x_3 + 12x_4 \leq 69840$$

$$x_1, x_2, x_3, x_4 \geq 200$$

Maple software is used to simplify the calculation to find every of x value, the maximum profit can be obtained when the company selling beach wear 200 pcs, beach cloth 200 pcs, Mukena 200 pcs, and bed sheet 5186 pcs, and the maximum profit reached by the company is IDR 16,560,000.

Determining the Optimum Value in Quarter III

Data used in the third quarter are taken in September, October, November and December.

$$f(X) = 2000x_1 + 2000x_2 + 1000x_3 + 3000x_4$$

With constraints:

$$2x_1 + 2x_2 + 3,6x_3 + 3,4x_4 \leq 24300$$

$$10x_1 + 13x_2 + 15x_3 + 12x_4 \leq 73440$$

$$x_1, x_2, x_3, x_4 \geq 400$$

Maple software is used to simplify the calculation to find every of x value, the maximum profit can be obtained when the company selling beach wear 400 pcs, beach cloth 400 pcs, Mukena 400 pcs and bed sheet 4853 pcs, and the maximum profit reached by the company IDR 16,560,000.

4. Conclusion

The conclusion based on the result of the research is if the company apply Karush Kuhn Tucker Method in producing Balinese motifs rayon fabric per its quarter, the maximum profit obtained is in the third quarter which able to gain IDR 16.560.000 by selling 400 pcs beach wear (x_1), 400 pcs beach cloth (x_2), 400 pcs, Mukena (x_3) and 4853 pcs bed sheet (x_4).

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