Optimal Production Quantity in Rubber Industry

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Abstract. The increasing demand for rubber makes rubber production companies continue to make improvements in production planning determination continuously in order to meet consumer demand. The largest rubber production company in Indonesia is still experiencing problems in its production activities. In some periods the company still often experiences production mismatches with consumer demand, especially in Centrifuged Latex products as the highest demand product. The incompatibility of the quantity of demands with the production amount results in the emergence of other costs and the company loses the chance to get maximum income. Consequently, it is essential to analyse the company making planning activities using the goal programming method. Based on the outcomes of data processing carried out, company profits with goal programming solutions of Rp. 43,778,032,320, which is an increase of 0.99% compared to production according to consumer demand. The percentage increase in profits is relatively small, this is shows that the production planning carried out by the company is optimal.

1. Introduction

The progress of a company can be seen from the increase in the quantity of consumer demands for the products produced. However, fluctuations in demand for the quantity of products from consumers can also cause problems in the management of resources which hamper the smooth process on the production floor. The smooth production process can be achieved by the right production planning activities by the company. This activity relates to what must be produced determination, how much is produced and what resources are needed to get the product planned. The goals of production planning can be concluded by way of many tails: deliver the volume and making to encounter arranged or predictable request, guarantee appropriate and positional accessibility of materials and mechanisms, provision of a steady flow of work through all departments, provide a balanced work between various departments involved in manufacture operation, make obtainable adequate manufacturing orders to allow good management, and management and archives and deliver passable information to capture letdown and postponement [1]. Production planning is a movement transaction with invention resolve, the quantity of making products, when the product is shaped, and the amount of labors wanted to become the creation resolve [2]. Production planning is a process of determination in the all level of manufacturing output to meet the planned level of sales and desired inventory. Production planning deals with volume, timeliness of completion, capacity utilization, and load planning determination. The production plan in this case must be coordinated with company planning. There are several types of production planning. Based on the time period, there will be long-period planning, medium-term planning, and short-term period planning. These three types of planning require different planning processes (also their input and output) at each other [3, 4].
Companies engaged in rubber product are still experiencing problems in the production process. The company is still experiencing obstacles in its production process. In some periods the company still often experiences production mismatches with consumer demand, especially in centrifuged latex products, which is the highest demand products. In some periods the company experienced inability to meet consumer demand and some periods experienced excess production. The excess production results in the emergence of excess stock which leads to the other costs such as storage costs and the company's goal to obtain maximum income is not achieved. Therefore companies need to do production planning in the optimal production quantity to meet consumer needs. Production planning in determination of optimal production quantity is done by several methods, one of them is the goal programming method. The goal programming method is the right method used in production planning because it has the potential to resolve conflicting aspects between elements in production planning, namely consumer, production, and manufacturing processes[5]. Goal Programming is one of a method that can solve the problem with more than one purposes. The objectives of Goal Programming method are to maximize profit of the company and minimize the distribution cost [6]. Goal programming is a branch of multi-objective optimization and a branch of multicriteria decision analysis, which is called optimization programming. Goal programming models are similar to the other linear programming models where linear programs only have one objective and goal programming have several objectives [7].

Research to overcome the problems of production planning has been done a lot before. The research was conducted by Wiwik Anggraeni in 2014 at a garment company that manufactures various types of products. Goal programming is used to determine the quantity of product combinations by paying attention to several objectives such as income maximization, production costs minimization and machine usage maximization. The result is production planning achieved by three objectives of production planning are to produce profits are greater than the profit target up to 4 times, production costs are smaller than expected production costs, machine usage is still below the engine of target usage and the planning production process is optimal because all of target deviation variables are 0 [8]. Other studies presented a research using goal programming to determine the tasks of the patrol administrators of manpower allocation. This method offers a non-linear goal programming model for patrolmen allocation problem to road sections within a patrol area. The model is applied via a situation case of the East section of Visakhapatnam. The consequences of the model are treasured to the watch administrator for seeing departmental goals and importance structure, in totalling to obtainable historical data, in the task of patrol manpower for a assumed urban zone [9].

2. Methodology
The research was conducted at one of the industries in Medan city produced centrifuged latex. The object examined in this study is the production volume of centrifuged latex for 1 year. Research starts with analyse to observe and see the state of the industry. After observation, the topic and purpose of the study are determined according to the conditions on the production floor. Then data collection is needed to overcome the problems of production planning occurs. Data collection in the form of the quantity of product demands, production cost, lead time, usage and availability of raw materials and the other data. The data collected is then processed using the goal programming method. The stages of the work process in overcoming the production planning problem begins with forecasting demand. Forecasting is done in order to estimate the volume of rubber production in the next period. Calculation of forecasting is done by the decomposition method and consider the smallest of error estimation value. The next step is to do production volume planning using the goal programming method. Goal Programming, the most commonly used goal programming solution methods were introduced by Lee (1972) and Ignizio (1976) [10, 12] other method using neural network prediction [11]. This method starts by determination of decision variables. Decision variables must be determined before formulating the objective function and constraints. After the decision is obtained, then the objective function and the constraints for the value of the objectives to be achieved are determined.
After that, the achievement function is determined by the decision variables combination with the objectives and constraints function. The function of achievement is done by using LINDO software to control the optimal manufacture amount. With this software, the optimal production quantity will be obtained for centrifuged latex.

3. Result and Discussion

3.1. Forecasting of Product Demand
Predicting conducted goals to forecast production volume in the following period by means of the decomposition method. Forecasting consequences are designated based on the minimum error estimation. Forecasting consequences obtained by decomposition methods consider the smallest error approximation can be seen in Figure 1.

![Figure 1. Forecasting Result of Centrifuged Latex Production for 1 Year](image)

Based on the diagram overhead, it can be seen that the volume of request for centrifuged latex products has fluctuated every period. The largest quantity of demands is in March. The smallest number of demands is in October. These outcomes indicate that here is a fluctuation in product demand for separately period order and good production planning is needed so that all stresses in each period can be fulfilled.

3.2. Production Planning Using Goal Programming

3.2.1. Determination of Decision Variables
Determination of decision variables is the basis for making a decision model to get the solution. Decision variables are outputs will be optimized and it meet the criteria of subjective, constraints and priorities. Decision variables for production planning in the company are as follows:

\[ X_1 = \text{Production Quantity of Centrifuged Latex at Each Month (kg)} \]  

3.2.2. Determination of Constraint Variables
Some variables in constraint functions formulation include:
1. Constraints of product lead time and availability of working hours for centrifuged latex product
Availability of working hours as a control function is used to see the relationship between production time and the quantity produced. Constraints function of product lead time and availability of working hours for centrifuged latex product in January is:

$$4X_1 \leq 2.401.200$$  \hspace{1cm} (2)

Formulation of Goal Programming method

$$4X_1 + d_1^- - d_1^+ = 2.401.200$$  \hspace{1cm} (3)

2. Constraints of the usage and availability of raw materials for centrifuged latex product

The usage and availability of raw materials as a function of constraints is to see the relationship between usage and availability of raw materials with the quantity of products produced. Constraints function of usage and availability of raw materials for centrifuged latex product in January is:

$$2X_1 \leq 900.000$$  \hspace{1cm} (4)

Formulation of Goal Programming method

$$2X_1 + d_2^- - d_2^+ = 900.000$$  \hspace{1cm} (5)

3.2.3. Determination of Objective Variables

The selection of objectives is based on information from company management and also based on conclusions taken from observations and data collection. The objective to be achieved is the demand meet for centrifuged latex, namely production maximization and profit maximization.

1. Production volume maximization

Forecasting result for the quantity of centrifuged latex production with a safety stock of 0,05% every month. Formulation of volume maximization in January is:

$$X_1 + 0.05X_1 \geq 339.803$$  \hspace{1cm} (6)

Formulation of Goal Programming method

$$X_1 + 0.05X_1 + d_2^- - d_2^+ = 339.803$$  \hspace{1cm} (7)

2. Profit maximization

Profit projections can be seen by taking into calculation the quantity of products and forecasting. Formulation of profit maximization in January is:

$$9.680X_1 \geq 3.289.283.360$$  \hspace{1cm} (8)

Formulation of Goal Programming method

$$9.680X_1 + d_4^- - d_4^+ = 3.289.283.36$$  \hspace{1cm} (9)

3.2.4. Determination of Achievement Functions

Achievement formulation for production planning optimization problems using Goal Programming is arranged based on the objectives to be achieved. The formulation of achievements for January is:

$$\text{Min } DA_1 + DA_2 + DB_3 + DB_4$$  
SUBJECT TO

$$X_1 + 0.05 X_1 + DB_3 - DA_3 = 339803$$

$$9680X_1 + DB_4 - DA_4 = 3289293040$$

$$4X_1 + DB_1 - DA_1 = 2401200$$

$$2X_1 + DB_2 - DA_2 = 900000$$

END

By using the formulation overhead, the objectives purpose and constraints purpose is calculated by means of the LINDO (Linear Interactive Discrete Optimizer) software to control the best creation quantity. Recapitulation of production planning for 12 months from Goal Programming achievements purpose by means of the LINDO software program shown in Table 1.
Table 1. Result of Optimal Production Quantity Using Goal Programming Method

| Month   | Optimal Production Quantity (Kg) |
|---------|----------------------------------|
| January | 339.803                          |
| February| 372.795                          |
| March   | 413.946                          |
| April   | 380.955                          |
| May     | 339.803                          |
| June    | 372.795                          |
| July    | 413.946                          |
| August  | 380.955                          |
| September| 339.803                     |
| October | 372.795                          |
| November| 413.946                          |
| December| 380.955                          |

The results of the Goal Programming method by means of the help of LINDO software program provides information about optimal completion. Based on the optimal results obtained through Goal Programming in Table 1, comparison of the quantity in actual production and recommendation shown in Table 2.

Table 2. Comparison of Actual and Recommendation in Optimal Production Quantity

| Month   | Optimal Production Quantity Actual (Kg) | Optimal Production Quantity Recommendation (Kg) |
|---------|----------------------------------------|-----------------------------------------------|
| January | 401.779                                 | 339.803                                       |
| February| 348.632                                 | 372.795                                       |
| March   | 214.960                                 | 413.946                                       |
| April   | 242.335                                 | 380.955                                       |
| May     | 334.980                                 | 339.803                                       |
| June    | 403.186                                 | 372.795                                       |
| July    | 375.098                                 | 413.946                                       |
| August  | 386.534                                 | 380.955                                       |
| September| 322.398                                | 339.803                                       |
| October | 307.764                                 | 372.795                                       |
| November| 400.352                                 | 413.946                                       |
| December| 285.771                                 | 380.955                                       |

Table above shows that the optimum quantity of centrifuged latex products must be produced every month using the goal programming method does not indicate the big difference from the quantity of production forecasting results are carried out using the company actual data.

4. Conclusion
Goal programming is used to control the best quantity of production and exploit the usage of fresh materials by resources utilization owned by the company. The optimum quantity of centrifuged latex products must be produced every month using the goal programming method does not indicate the big difference from the quantity of production forecasting results are carried out using the company actual data.
data. The company's advantage with goal programming solutions is IDR 43,778,032,320, which only increased by 0.99% compared to production based to consumer demand. The percentage increase in profits is relatively small, this shows that the production planning carried out by the company is optimal.

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