Approaches Of Linear Programming For Production Planning Optimization

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ABSTRACT

The secret to success in any industry in the globalization era is integrated planning for production, manpower, and capacity. A mathematical model for estimating the ideal needed manpower, lot size, and capacity is developed in this study. The three goals of this linear programming model are to maximize production quantity, minimize production costs, and maximize capacity utilization. Making judgments about how effectively to allocate scarce resources is a responsibility of the production manager in order to ensure maximum utilization of those resources on the production floor. In this research, linear programming techniques are used to tackle a production planning problem at a feed mill producing company. The linear programming model was built using the company's daily activity data. Data processing was done using Management Scientist Version 5.0. According to the report, increasing profit can be achieved by eliminating less profitable products and simplifying the product line.

This implies that in order to increase monthly profit, the business might use the results of linear programming techniques in production planning. This study has demonstrated the effectiveness of linear programming approaches as tools for managers to use when making decisions, allocating scarce resources, and identifying opportunities for improving operations and profits.

INTRODUCTION

The goal of maximizing profit in any business organization, such as a production or manufacturing corporation, is not new, despite the fact that many business organizations view linear programming as a "new science" or a relatively recent development in mathematical history. During World War II, linear programming emerged as a means of resolving issues related to military logistics. In today's contemporary civilizations, it is still one of the mathematical strategies used. The creation of linear programming is considered one of the most significant scientific discoveries of the middle of the 20th century.

Many production organizations occasionally struggle with how to use the resources at their disposal to maximize profit; this is because linear programming, which provides a useful quantitative approach to decision-making, has not always been properly used. The majority of production managers base their decisions on the overall amount of input consumed throughout the production and output process. This decision-making process is inherently biased, which reduces the accuracy of future forecasts on things like price fluctuations and shortages of raw materials or other resources. One of the main causes of the use of the linear programming model, which is currently one of the most potent instruments that all decision makers (managers) must employ before reaching an effective conclusion, was the issue of decision making based on the use of limited resources.

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A method of problem-solving called linear programming (LP) was created to assist managers in making choices. The competitive corporate landscape of today has several uses for linear programming Anderson (1). Dantzig (2) coined the phrase "linear programming" in 1947 to describe a subset of optimization problems where the objective function and constraints are assumed to be linear.

Soon after, LP was widely used in industry; the petroleum, petrochemical, and food sectors saw the greatest success with its use (2, 3). Not only has linear programming been used extensively for more than 40 years to represent many economic and productive systems, but it is also a well-established modeling tool for scheduling and distribution issues. While computer tools for solving large LP models are extensively developed and widely available, such as (Dash Assoc., 1993), the mathematics of linear programming is well established and described in a number of books (3-6). One specific tool for making mathematical decisions is linear programming.

Numerous fields, including agriculture, manufacturing, transportation, economics, health care, behavioral and social sciences, and the armed forces, use the linear programming technique. Production planning can benefit from the application of linear programming (LP), which maximizes the distribution of resources like personnel, equipment, and materials. It assists in figuring out the best production levels to satisfy demand while keeping expenses to a minimum. Constraints pertaining to labor availability, inventory limits, and production capacities can be incorporated into linear programming models.

REVIEW OF LITERATURE

In order to achieve profit maximization, Akpan and Iwok (2018) employed the concept of the Simplex algorithm, which is a component of linear programming and involves allocating raw materials to the large, huge, and tiny loaf finishing variables in the bakery. After the assessment was completed, the results showed that in order to achieve the profit of N20385, little loaf (963 units), big loaf (39 units), and huge bread (1 units) need be produced, correspondingly. According to the evaluation, the contribution of little and large loaves to the profit was found to be properly balanced. Thus, in order to maximize profit, more little and large loaves have to be made (7).

Workie, Alemu, and Asmelash (2016) (8) used linear programming applications in the textile industry. In the joint venture, there were eight completed textiles. The calculations were carried out using an add-in solver for Microsoft Excel. Using the linear programming method, which is a useful analysis procedure and a natural instrument for decision support, the obtained data was mathematically represented. In comparison to methods derived from trial and error approaches, which can increase revenue by 72.63% and 65.91%, respectively, linear programming offers a faster and more efficient way to choose the kind and quantity of colored textile materials to be produced that generate more revenue by helping managers allocate resources to their best uses and identify the economic circumstances surrounding underutilized resources (8).

A mathematical model was developed by Jyothi, Rao, and Sivasundari (2019) to determine the optimal feasible needed lot size, labor force, and capacity. Here, we employ the production planning methods already in use in a mobile production unit that generates electrical components for vehicles using a single item flow. This linear programming model has three main objectives: minimizing manufacturing costs, maximizing production quantities, and optimizing the use of abilities. It must be handled by approaching each goal in turn as a Lexicographic method. For validation, the model's outputs are compared to actual observed values (9).

For a textile industry, Campo et al. (2018) proposed and applied an collective construction planning model to supply optimal techniques in the medium tenure. A linear programming model was also suggested to reduce overall expenses associated with work and stock levels. The suggested model takes into account aspects related to textile control, process wastes, the efficiency of hiring new employees, and training needs. The model was implemented and solved using GAMS, using Microsoft Excel assistance for calculating the best solution (10).

In order to provide a production picture and optimize Bintang Bakery's revenues in the housing market, Anggoro et al. (2019) conducted study. To strengthen the benefits of the Bintang Bakery home market is the aim of this research study. Lindo tools were utilized for the performance of profit optimization estimations. The production outputs utilized by the residential sector of Bintang Bakery are optimal, as demonstrated by the outcomes of calculations utilizing the Lindo and simplex approaches. By applying the simplex strategy, the Celebrity Bakery sector produced 3740 savored pieces of bread, 1300 packaged bread rolls, and 520 loaves of bread packing, with an optimal profit degree of Rp 19,750,000. This resulted in a gain in earnings of Rp 250,000. (11).

Production is a crucial function within businesses that involves converting input resources into the necessary outputs, or goods. In order to generate or improve a product's utility for customers, manufacture need converting single type of material into a different form through chemical or mechanical processes. It's a method of adding value. Production is the process by which commodities and services are created. The main focus of production is on transforming or converting inputs into completed goods and services (12).

According to the wild (13) manufacturing planning, is the process of identifying, acquiring, and setting up all the facilities required for an item's manufacturing. One of the most important tasks for a production manager is production planning, which involves deciding what goals need to be accomplished during the production process and how best to combine resources (input) to get there.

Production planning creates a thorough plan and calculates the resources needed to accomplish the production objectives quickly and effectively (14). Production planning, which demonstrates the way and synchronization of organizations' assets towards achieving their predetermined goals, is a fundamental manufacturing management function applicable in all manufacturing companies (15). Effectiveness and efficiency on the industrial floor can only be achieved with planning (16).

It provides supervision on what requirements to be formed, how we want to accomplish it, and what materials are needed to make it happen. The process of production planning entails coming up with, identifying, and choosing the best possible alternative course of action. According to Goutham (16), production planning improves a manufacturing entity's performance, especially when the company operates in an unpredictable environment. Production planning raises an organization's operational efficiency, claim Umoh et al. (17).

Production planning helps managers improve the system and production process in an uncertain environment. Higgins asserts that businesses that effectively incorporate production planning into their operations perform better than those that use an ad hoc strategy (18). Goutham (16) asserts that production planning is essential to ensuring optimization.

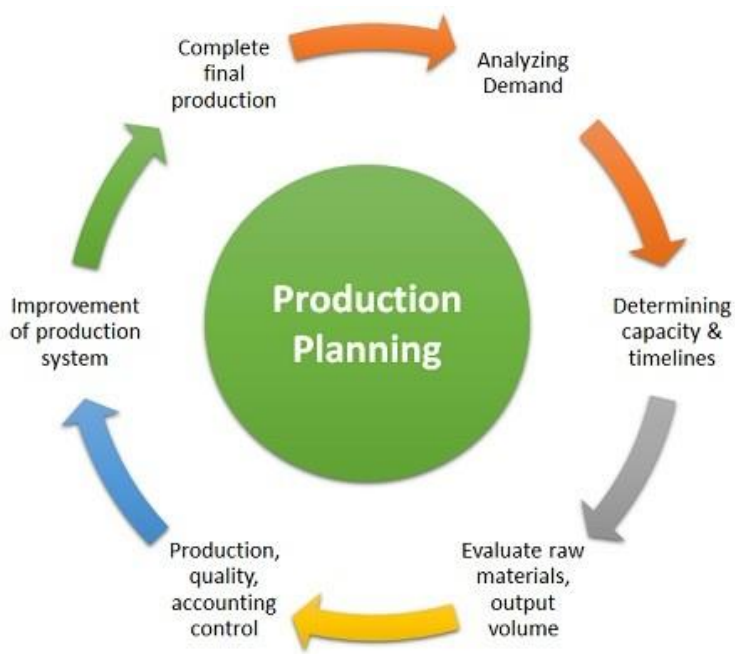

Figure 1. Scheme of Production planning

MATERIAL AND METHODS

The production manager provided clarity and explanation for certain aspects of the dataset, while the study's data came from the company's record book. Data on the mix of these essential raw materials, their costs, and the amount of each raw material utilized each month were acquired. Lastly, information about the production costs of the company's four goods was gathered.

Profit maximization was the study's main goal. Where Xi is the amount of bags completed for every product (i = 1,2,3,4) and Ci is the profit earned from the sales of the products (i = 1,2,3,4).

$Z = C_1X_1 + C_2X_2 + C_3X_3 + C_4X_4$

s.t.

$a_{11}x_1+a_{12}x_2 +a_{13}x_3+a_{14}x_4 \leq b1$

$a_{12}x_1+a_{22}x_2 +a_{23}x_3+a_{24}x_4 \leq b2$

$a_{13}x_1+a_{22}x_2 +a_{33}x_3+a_{34}x_4 \leq b3$

$aj_1x_1+aj_2x_2 +aj_3x_3+aj_4x_4 \leq bj$

Non-Negativity = X1, X2, X3, X4, X5 ≥0

It is possible to write the model in this canonical form.

$$Z= \sum_{j=1}^{4} C_jX_j$$

S.t..

$$\sum_{j=1,2,\ldots 4}^{15} a_{ij}x_j \leq bj$$

j= Layer Mash, Grower Mash, Broiler Starter Mash and Broiler Finisher Mash.

i = kg of materials to be used

bi = Resources available

Linear programming model of the company

Maximize $Z= C_1X_1 + C_2X_2 + C_3X_3 + C_4X_4$

Maximize $Z= 207.25X_1 + 97.75X_2 + 128.75X_3 + 153.5X_4$

s.t.

	Input Used
$13.5X_1 + 11.2X_2 + 15X_3 + 13X_4 \leq 12,000$	(Rice)
$6X_1 + 4.5X_2 + 6.5X_3 + 6X_4 \leq 2,200$	(Soya Beans)
$2X_1 + X_2 + 0.75X_3 + 2X_4 \leq 1,840$	(Lime Stone)
$0.65X_1 + X_2 + 0.5X_3 + 0.65X_4 \leq 1900$	(Bone)
$2.75X_1 + 4.5X_2 + 2X_3 + 2.5X_4 \leq 7,800$	(Wheat Offal)
$0.1X_1 + 0.05X_2 + 0.075X_3 + 0.1X_4 \leq 100$	(Salt)
$0X_1 + 0.063X_2 + 0X_3 + 0X_4 \leq 26$	(Grower Premix)
$X_1, X_2, X_3, X_4 \geq 0$	(Non-Negativity)

Methods for Model Solution: The Management Scientist Version 5.0 was used to solve the model.

RESULTS AND DISCUSSION

This study's formulation of a linear programming model for the feed manufacturing company's production planning challenge spans a month. With a monthly profit potential of N 32,028.75, the company generates a mix of 40 bags of layer mash, 100 bags of grower mash, 25 bags of broiler starter mash, and 70 bags of broiler finisher mash.

Materials					
Materials	**Layer Mash (kg)**	**Grower Mash (kg)**	**Broiler starter Mash (kg)**	**Broiler Finisher Mash (kg)**	**Available Quantity per month**
Rice	14.3	11.5	13	17	12,000
Soyabean	5	5.6	6.6	4	2,200
Lime stone	4	3	2.3	2	1,840
Bone	0.89	0.77	4.7	1	1900
Wheat offal	2.75	0.4	2	0.07	7,800
Salt	6.5	0.05	0.09	1.12	100
Grower premix	2	0.003	0	0.09	26

Table 1 Materials used in the production

Table 2 shows the cost of producing, selling and expected profit from a bag of Layer Mash, Grower Mash, Broiler Starter Mash and Broiler Finisher Mash.

Product	Parameter	Expected Cost of Production a bag (N)	Expected Selling Price of a bag (N)	Expected Profit on a bag (N)
Layer mash	C_1	2,789.56	2800	234.75
Grower mash	C_2	3240.00	2300	543.50
Broiler start mash	C_3	5376.55	4000	323.00
Broiler finisher mash	C_4	2311.00	2100	435.50
Total				1536.75

Table 2: Production Costs Per Kilogram on Average for All Products

CONCLUSION

The study's findings demonstrate that while the use of heuristic approaches in production planning can lead to resource waste on the manufacturing floor, they do not ensure the best possible outcome. Additionally, a production manager should use the effective strategy of applying linear programming practices to manufacture planning. By doing so, the company's performance will be improved and total profit will increase. The research also shows that resource optimization—which will benefit the business more than profit maximization—is what production companies should be aiming for instead of just maximizing profits. The study concludes that linear programming can be used to handle any problem pertaining to production planning.

Such problems can be solved incredibly easily, quickly, and accurately by mathematical models when they take into consideration the predetermined objectives and aims.

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