International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 11 | November - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

Strategic Profit Maximization through Linear Programming in Wood Furniture Manufacturing

Meghana.N[1], Anitha Jandhyala[2]
[1]Student, BBA Department, PES University
[2]Associate Professor, BBA Department, PES University
PES University, Bengaluru Karnataka

ABSTRACT

The case study illustrates the use of Linear Programming Technique in optimizing the profits yield in the sales of the wooden furniture's sold by Gajanana wood works. The data collected is a primary data which was collected manually from the owner of the firm.

A Linear Programming Problem (LPP) was formed with the help of the data collected along with the constraints. The constraints considered were sales expected per month for both cot and dining table, the capacity of the firm for producing the products in a month and the availability of the raw materials in the process. The objective function is to maximize the profit attained from the production. Data utilized to form the constraints include forecasted sales for the products and the procurement and optimum utilization of the resources. . The LPP hence formed was solved using 2 methods – graphical and simplex.

KEY WORDS: Simplex Method, Graphical Method, Linear Programming Problem (LPP), Constraints, Objective Function, Optimal Solution, Production Capability, Raw Materials, Feasible Region, Excel Solver, Maximization of profit.

INTRODUCTION

Operations research focuses on using analytical and mathematical techniques for optimal decision-making. It enhances manufacturing efficiency and ensures optimal use of raw materials, contributing to informed decision-making. Linear programming is a widely-used mathematical tool in operations research, especially in situations with multiple constraints.

Linear programming is employed to find the best outcomes when faced with numerous constraints during the optimization process. It is particularly effective in scenarios where the objective is to maximize profits or minimize costs, considering existing limitations. Businesses using linear programming typically have an objective function, decision variables, and constraints.

Decision variables represent choices like production quantities or resource allocations, while constraints include factors such as production capacity, resource availability, or budget limitations. The main objective, whether minimizing costs or maximizing profits, forms the business's objective function.

The linear programming model for profit maximization involves formulating inequalities or linear equations based on decision variables, constraints, and the objective function. The aim is to identify decision variable values that maximize profit while meeting all requirements. This process yields the best solution for achieving maximum profit within specified constraints.

Gajanana wood-works

Established in 1998 by Mr. Ningesh in Chikkamagaluru district, Traikere taluk, Gajanana Wood Work is a 100% wooden furniture workshop producing cots, dining tables, doors, windows, chairs, and study tables in a 6-square-foot, 25-year-old warehouse. The 10 permanent labourers utilize machinery like wood cutter, wood planer, router, band saw, lathe machine, pillar drill, grove machine, air compressor, and spray machine. Cot production requires 3 square feet of teak wood, involving 3 labourers paid a total of 7000 for a 6-day production period. A 10% profit is targeted, with cot prices ranging from 5000 to 14000.

Dining tables use 5 square feet of teak wood, with 5 labourers receiving 12000 to 15000 per unit over 6 days. A 20% profit is expected, and prices vary between 35000 and 40000.

In essence, Gajanana Wood Work is a well-established furniture workshop with specific production processes, a dedicated workforce, and profit expectations for cots and dining tables.

OBJECTIVES

- Understanding the importance of LPP in Real-World Application.
- Identifying the best suitable strategy for profit maximization.
- Optimum procurement and allocation of the raw materials.

LITERATURE REVIW

1. In this study, Linear Programming (LP) was applied to address cost reduction challenges in the fictional furniture production firm, Simple Furniture. The LP model aimed to align manufacturing goals with cost constraints, optimizing the distribution of resources like worker hours, production rates, and materials. The research focused on minimizing costs while providing data-driven recommendations for efficient budgeting and production scheduling. The goal was to empower administration with insights to enhance decision-making in resource allocation and cost control for effective manufacturing.
   (Soni, 2023)

2. This article uses linear programming method to analyse the sales packages required for the production of medicated soap in KASMO industry, Nigeria. It analyses that the profitability of one tablet per pack when concentrated on with a profit of N14.36 of every soap tablet is about N271296. Since the study only considers the raw materials cost, the results may vary when other cost are considered. Anyhow they provide helpful isights for the KIL's marketing and manufacturing plans.
   (Yahya, 2012)
3. This study mainly focuses on assisting the small and medium sized businesses in optimizing a proper production process and efficient allocation of resources. It gives us helpful insights in increasing the profits in the context of water by using linear programming to understand the proper product mix for ABC Sdn Bhd.
   (Baki, 2021)
4. This study is done to introduce an optimization model to control the energy through conventional, photovoltaic, and battery sources, in order to fulfil the demand along with maximizing the profit. It gives a relevant and speedy solution by using the linear programming method with an appropriate number of variables and restrictions. This model gives us an effective method of using the resources available from various energy sources by allowing numerous days and time increments.
   (Torres, December 2014)
5. This paper uses linear programming method to maximise the resources allocated in the industrial sector to the Bajabure Industrial Complex in Nigeria. It suggests focusing on the 25 kg and 29 kg density sales bundles for the highest monthly profit of roughly #524,369 based on data analysis on foam items. It admits that adding the costs, labour and overhead will result in different outcomes. Anyhow it gives helpful insights for the business production and marketing plans.
   (Muhammad, 2015)
6. To increase the production of bread at the University of Benin Bakery in Nigeria, this study uses the linear programming method. According to the research production of 667 extra-large bread units per day can result in a daily profit of up to $100000. Considering the limitations, producing medium and large bread production effect only little on the profits. Hence in insists on concentrating on the production of the extra-large bread production to maximize the profits.
   (Oluwaseyi, 2020)
7. There are various business, economic problems that needs to come up with solutions considering a lot of constraints into account, it includes capacity, labour, market and budget. Coming up with efficient techniques for these constraints and assessing the financial impact of these constraints and whether it is profitable to change them are essential if these issues are to be resolved successfully.

(A. Charnes, 1953 1 may)

8. The study investigates the use of linear programming model in the field of agriculture in helping the farmers to take effective decisions and optimum allocation and utilization of resources. It shows us how the linear programming model encourages a better environmental resources management, production necessity fulfilment and profitability. There is a use of other mathematical programs as although LP is proven effective, it has some flows while dealing with multiple goals related problem.
   (Nadeem, 2021)
9. The study mainly focuses on the importance of pharmaceutical sector for human healthcare, employment generation and the global economy. The Sobhan Darou Pharmaceutical Company maximises the production using linear programming method to reduce the cost and maximise the profits. Prior production rate calculation and effective allocation of resources are made possible by the use of Linea Programming method's ability to consider both tangible and intangible factors.
   (Hamdollahzadeh, 2016)
10. This paper focuses on two housing development projects which are situated in Indonesia, demonstrates how linear programming method can maximize the profits. It shows the importance of sensitivity analysis in finding out the variables that are effecting the profitability. It also states that a projects profit margin can be relative, with the first project having an increasing return on investment and being more adaptable to changes than the second.
    (Hasanah, 2019)
11. This study focuses on optimizing product mixes and understanding the perspective of the retailers in customer segments. Using linear programming to evaluate the utilisation of resources resulted in more cost effective pricing and a 54% increase in profit. It emphasises on how affordable it is to use Excel in making decisions about product mix.
    (RubyChanda, 2022)
12. This study shows how Linear Programming model was used in maximizing the profits by focusing on four different bread sizes. Producing three large kings' bread size units will yield more profit than the initial level. This also states that a product will be discontinued if its profit contribution is zero.
    (A, 2019)
13. At a high competition market timely production plays an important role in maintaining the customer loyalty and maximizing the profits. By keeping in mind the production planning and reducing the cost while considering the time into account, they are framing a linear programming model.
    (Ghosh, 2020)

14. This study is done by Ethiopian chemical company to maximise the profits. It resulted that the profit variations were caused by subjective decision making. With the help of quantitative methodology, they came up with a linear programming model that resulted in a daily profit of 107353.19. This illustrates that applying quantitative decision making techniques results in profit maximization.
    (Maurya, 2015)
15. Here a revised simplex method was used to analyse secondary data, with a major focus on the most profitable industry i.e. Chicken production. The production of Jollof rice should be lowered due to its limited ability to advance the company, and improvements to product quality should be made in order to meet consumer demand.
    (OZOKERAHA, 2020)

RESEARCH METHEDOLOGY

The primary data for this project was directly collected from the owner of the company.

The data collected is of the type quantitative data.

Here we are using the non-probability sampling method which is collecting the data directly from the firm owner in a subjective way. The data collected here is primary data. It was collected directly by contacting the manager of the warehouse. The main purpose of collecting the data is just for the research purpose.

The convenience sampling method of the sampling technique is used here. This method is majorly used in the researches because they are not that complicated. This method is used to collect the data from a pool of data which is relevant to the researcher's choice.

x: let x be the number of cots to be produced in a month.

y: let y be the number of dining tables to be produced in a month.

The constraints formed are here are taken from the information given below.

The objective function here is to maximize the profit, which is Rs 5000 from the cots and Rs 9000 from the dining tables.

The selling price of one cot is 50000, and one dining table is 90000.

Maximize Z = 5000x+9000y

CONSTRAINTS

- Production capacity constraint:

The facilities, labours and the machinery available in the firm is only applicable to produce 100 units. That is both cot and dining table production can be together produced to a maximum of 100 units. The constraints are:

$x + y \leq 100$

- Raw materials availability constraint:

The production of the furniture's are done in teak wood which are sourced from an external producer. The raw materials available are limited and has to be utilized effectively. The production of 1 unit of cot requires 3 square feet of wood, and the production of 1 unit of dining table requires 5 square feet of the wood. The firm can attain only 300 square feet of teak wood. The constraints are:

$3x + 5y \leq 300$

- Sales constraint:

The firm has to maintain a minimum sales so that they can maintain a sustainable profit and also maintain a competitive edge in the market. They have to sell at least 10 unit of cots and 20 units of dining table to attain profits. The constraints are:

$x \geq 10$

$y \geq 20.$

The constraints mentioned here are essential for optimal production process so that the raw materials available are allocated and used in an optimal way while meeting the required production and sales requirements.

The non-negative constraints are also considered in the problem because the production of the furniture's should not be equal to zero, hence:

$x \geq 0$, & $y \geq 0$

Linear Programming Method in maximizing the profit

Maximize $Z = 5000x+9000y$

Subjected to

$x + y \leq 100$ (production capacity)

$3x + 5y \leq 300$ (raw materials)

$x \geq 10$ (sales)

$y \geq 20$ (sales)

$x \geq 0$ & $y \geq 0$ (non-negative constrains)

DATA ANALYSIS

Solving the problem using 2 methods:

- Method I: Graphical Method
- Method II: Simplex Method

Method I: solving the problem through graphical method:

Step 1: converting the inequalities to equalities and substituting x and y as zero so as to find the other values.

- $x + y \leq 100 \Rightarrow x + y = 100$

  Substituting x as 0, y = 100 (0, 100)

  Substituting y as 0, x = 100 (100, 0)
- $3x + 5y \leq 300 \Rightarrow 3x + 5y = 300$

  Substituting x as 0, y = 60 (0, 60)

  Substituting y as 0, x = 100 (100, 0)
- $x \geq 10 \Rightarrow x = 10(10, 0)$
- $y \geq 20 \Rightarrow y = 20 (0, 20)$

Step 2: Graphical Representation:

Graph 1: feasible points of the solution

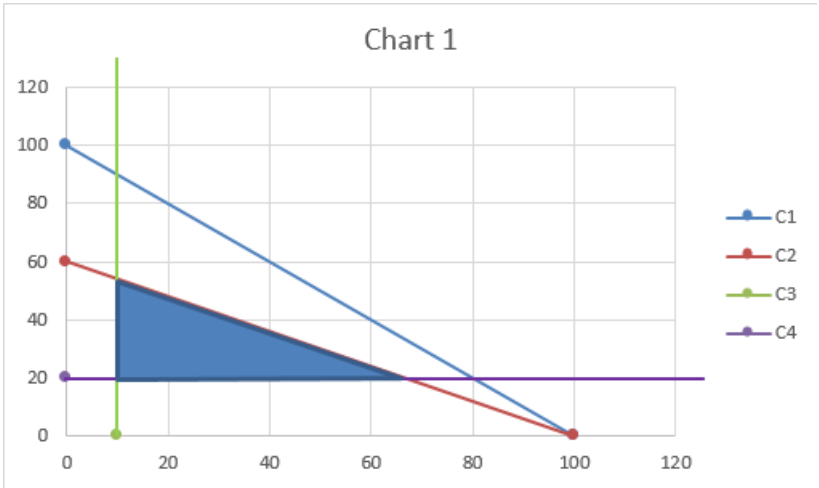

Chart 1 shows the feasible points obtained from solving the problem in graphically.

Step 3: Feasible Points

Table 1: Feasible Region Points from the Graphical Method

Feasible region		z=5000x+9000y
x	y	
0	0	0
10	54	5,36,000
66.5	0	3,32,500

Table 1 demonstrates the feasible region points obtained from the graphical solution.

The Graphical method provides us with the following solution:

Maximum Z = 5, 36,000

When x = 10 y = 54

From the solution obtained from the graphical method we can illustrate that the firm should manufacture 10 units of cots and 54 units of dining table.

Method II: solving through simplex method:

The problem solved by simplex method:

Table 2: Constraints formed by the data

Variables	x	y	
Variables	0	0	0
Co-efficient	5000	9000	

Constraints	x	y		RHS
C1	1	1	≤	100
C2	3	5	≤	300
C3	1		≥	10
C4		1	≥	20

Table 2 shows the constraints that are obtained from the given data about the firm.

Solution: (solved in excel solver)

Table 3: Data solved using Excel Solver by Simplex LP Method

Variables	x	y	
Variables	10	54	536000
Co-efficient	5000	9000	

Constraints	x	y		RHS
C1	1	1	≤	100
C2	3	5	≤	300
C3	1		≥	10
C4		1	≥	20

Table 3 shows the solution obtained after solving constraints by the data solver in excel.

The simplex method gives the following solution:

Maximum Z = 536000

When x = 10 & y = 54

CONCLUSION

The main purpose of the research was to find out the optimal solution which led to the maximization of profits and help the business to maintain a competitive edge in the market, by using the Simplex Method and graphical method with the help of MS Excel. From the study it was found that if Gajanana wood works sold 10 units of cot and 54 units of dining table, it would lead them in attaining maximum profit of Rs 5, 36,000. By applying this strategy the Gajanana wood works would yield a maximum profit along with optimal utilization of the raw materials, human resources, machineries and technology available. The study also illustrates that using Simplex Method by a business will yield an optimum solution for both maximizing the profits and minimizing the production cost.

REFRENCES

A, O. E. (2019). Application of Linear Programming to Profit Maximization (A Case Study of Johnsons Nig. Ltd) . *Journal of Advances in Mathematical & Computational Sciences* , Vol. 7, No. 1. Pp 11-20 .

A. Charnes, W. W. (1953 1 may). Linear Programming and Profit Preference Scheduling for a Manufacturing Firm. *informs pubs online*.

Baki, S. M. (2021). A Linear Programming Model for Product Mix Profit Maximization in A Small Medium Enterprise Company. *INTERNATIONAL JOURNAL OF INDUSTRIAL MANAGEMENT* , volume 9.

Ghosh, S. K. (2020). DEVELOPING A LINEAR PROGRAMMING MODEL TO MAXIMIZE PROFIT WITH MINIMIZED LEAD TIME OF A COMPOSITE TEXTILE MILL. *ITEGAM-JETIA*.

Hamdollahzadeh, A. (2016). A Model to Determine Optimal Composition of Production to Obtain Maximum Profit & Reduce Overhead Costs by Linear Programming . *Canadian Center of Science and Education* , vol 10, no 10.

Hasanah, U. (2019). Applying Linear Programming in Business Decision Making: A Case of Profit Maximization of a Commercial HousingDevelopment. *International Institute for Science, Technology and Education (IISTE): E-Journals*, Vol.11, No.19.

Maurya, V. N. (2015). Profit Optimization Using Linear Programming Model: A Case Study of Ethiopian Chemical Company . *American Journal of Biological and Environmental Statistics* .

Muhammad, U. (2015). Profit Maximization in a Product Mix Company Using Linear Programming Approach to Resource Allocation. *International Journal of Sciences: Basic and Applied Research* .

Nadeem, F. (2021). A Review of Applications of Linear Programming to Optimize Agricultural Solutions. *modern education and computer science*.

Oluwaseyi, K. O. (2020). Profit Maximization in a Product Mix Bakery Using Linear Programming Technique . *Journal of Investment and Management* , 27-30 .

OZOKERAHA, C. F. (2020). APPLICATION OF LINEAR PROGRAMMING IN PROFIT MAXIMIZATION AT GLAD TIDINGS (GT) FOODS, BENIN CITY, EDO STATE, NIGERIA. *Innovative Journal of Science* , Volume 1, Issue 1, .

RubyChanda. (2022). AStudyonApplicationofLinear ProgrammingonProductMixforProfit MaximizationandCostOptimization. *INDIANJOURNALOFSCIENCEANDTECHNOLOGY*.

Soni, T. (2023). Optimizing the Cost Effectiveness in a Manufacturing sector: A Linear Programming Approach for Simple Furniture. *International Journal of Enhanced Research in Management & Computer Applications* .

Torres, D. (December 2014). Scheduling coupled photovoltaic, battery and conventional energy sources to maximize profit using linear programming. *Renewable Energy*, Pages 284-290.

Vakilifard, H. (March 2013). Profit Optimization with Post Optimality Analysis Using Linear Programming . *World Journal of Social Sciences* , Vol. 3. No. 2.

Yahya, W. B. (2012). Profit Maximization In A Product Mix Company Using Linear Programming . *European Journal of Business and Management* , Vol 4, No.17.