Maximizing Automation Company Profits: The Linear Programming Approach

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Abstract

The study conducted implements Linear Programming technique to optimize the profits of VNC Automation. Primary data which was sourced from the company's director, is the foundation for the analysis. The key constraints considered for the analysis were demand and production time available to meet this demand. The resulting LPP hence formed was solved using 2 methods – graphical approach and simplex method. This methodical approach adopted enhances the robustness of the analysis offering a comprehensive perspective on profit optimization.

Keywords: LPP-Linear Programming Problem, constraints, profit maximization, optimal solution, Simplex method

Introduction

Operations research or OR is a multidisciplinary subject that uses mathematical principles to solve complex real-life problems. Also referred to as "management science" includes techniques from fields such as mathematics, statistics and computer science for process optimization, improve system and achieve organizational efficiency through minimizing cost, and maximizing benefits.

One such techniques is Linear Programming. It is an optimization technique used for situations with limited resources and there is need for optimum allocation. It consists an objective function that have to be maximized or minimized subject to a series of constraints that need to be met. The main goal of Linear Programming is determining the optimum values of the decision variable whilst the constraints are satisfied and the objective function is optimized.

Objectives

- To understand the application of Linear Programming Problem in real world settings.
- To find the optimal profit maximization point for the company.

VNC Automation

VNC Automation is a private limited company providing assembly solutions and torque products relevant to industry 4.0. They are authorised Channel Partners for Atlas Copco, Eepos, Tech Metro and Gedore and sources its materials from them. The products considered for the purpose of this study is

Product A – Industrial tools

Product B – Industrial Moving Solutions

Literature review

1. (Yahya, 2012) explores the application of Linear Programming in a soap manufacturing industry in Nigeria with the aim of optimizing the production and improving sales strategy. The results indicate that the profit can be maximized with a focus on selling individual soap tablets.
2. (Oluwasey, 2020) uses Linear Programming to determine the daily production quantity of a bakery in Nigeria. The best solution is to maximize the profit is found through the Linear Programming Model.
3. (Muhammad, 2016) studies foam product densities to determine a optimal production mix that maximizes the profit. It is a demonstration of the effectiveness of Linear Programming techniques.
4. (A O. E., 2019) uses the Linear Programming technique and simplex to optimize production in a bakery in Nigeria. It also uses sensitivity analysis to maintain the feasibility of the solution.
5. (Chanda, 2022) studies the optimal production mix for retailers in a small town with limited resources. There has been a 54% increase in the profit after utilizing the linear programming technique highlighting its effectiveness even to small retailers.
6. (Haris, 2023) studies the importance of linear programming in a automotive industry and recommends the quantity of production to maximize profit. The linear programming model is created considering 6 products and 5 constraints.
7. (Akpan, 2017) this study uses Karmakar's approach to a linear programming problem. It suggests prioritization of production of a certain product to improve profitability of Coca-Cola.

8. (Kalwar, 2022) this case explores a linear programming model to optimize the production quantity of a footwear company in Lahore, Pakistan. It predicts that implementing the proposed model has the potential to increase the profit by 39% with about 22% lesser production.
9. (Jain, 2021) applies Linear programming in a small FMCG company manufacturing toothpaste. The objective is to determine the optimal production quantity of ayurvedic mixture and toothpaste. The optimum profit is found using LPP which is producing 230 packets of type 1 product and 200 packets of type 2.
10. (A R. , 2013) considers the dry season on Nigeria. With limited land, producing vegetables is a problem. The paper suggests an optimal crop mix to increase productivity and income.
11. (O, 2019) determines the optimal bread size that maximizes the profit using LPP. It paves way for further application in further diverse disciplines.
12. (Reeb, 2013) studies that application of Linear Programming for economical allocation of scarce resources, promoting it as a valuable decision-making tool.
13. (Kennedy, 2012) studies 2 Linear Programming models to incorporate the risk factor in farm models.
14. (An, 2021) presents a Linear Programming model for large-scale problems in the service industry (airline industry).
15. (Ahmed, 2015) suggests using Linear Programming and Simplex to maximize profits of a project. It highlights the reliability of the method even with ill-conditioned equations.
16. (Nischal N, 2023) analyses the manufacturing process of a chemical plant to determine the profit optimization value through the help of linear programming technique.

Research Methodology

The required quantitative data to form the LPP was collected from the director of the organization. Data hence collected is not random and was selected based on pre-determined purpose with the aim of obtaining accurate values. That is the sampling method used is non-probability sampling.

Data Analysis

Variables:

'x' is assumed to be the number of units of product A that are to be produced in 390 working hours

'y' is assumed to be the number of units of product B that are to be produced 390 working hours

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Objective Function:

Maximize the total profit

Profit percentage on Product A-17% and the selling price is 3L and

B-25% with the selling price of 8L

Maximize: **0.25*800000x+0.17*300000y/ 200000x + 51000y**

Constraints

The market demand for the time period of 2 months is forecasted as follows

$x \leq 30$(Product A demand)

$y \leq 10$ (Product B demand)

The materials are produced in batches. Product A has 100 units per batch and Product C has 50 units per batch. The time of production of a single unit of Product A and B are calculated to be 10 hours and 15 hours respectively.

The total time available to produce the products and meet the demand is 390 working hours or 65 days (Considering 6 working hours per day). Incapability to adhere to the time restrictions might result in losing the customers.

$10x+15y \leq 390$ (Time constraint)

Method 1: Graphical Solution

Substituting 'x' and 'y' as zeros to convert the inequalities to equalities

1. $x \leq 30$

Substituting y=0, x=30

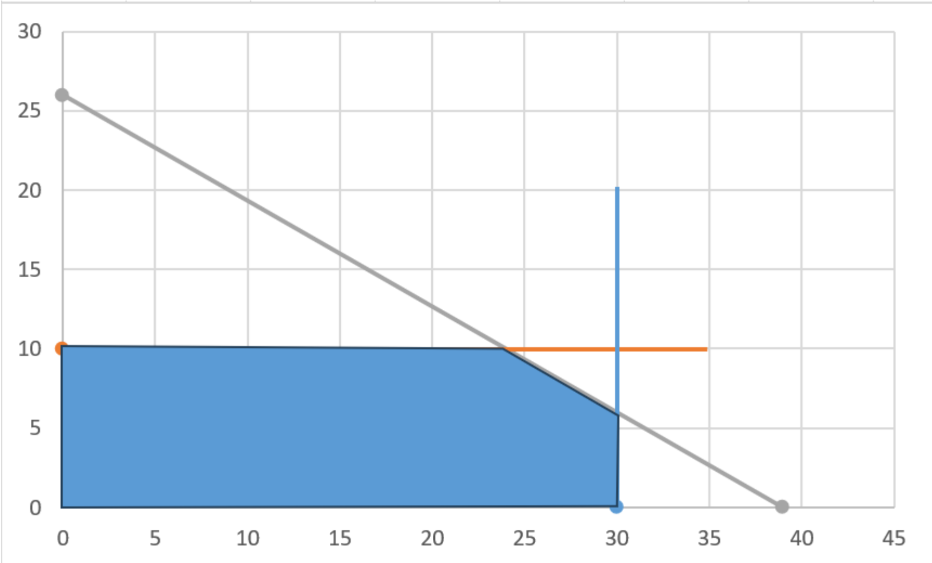
2. $y \leq 10$

Substituting x=0, y=10

3. $10x+15y \leq 390$

Substituting x=0, y=26; y=0, x=39

Graphical representation of the above constraints is as follows



In the above graph the blue line represents the first demand constraint; the orange line represents the second demand constraint and the grey line represents the third time constraint.

Table below shows the feasible points from the above graph

Feasible points	**Z= 51000x+200000y**
0,0	0
0,10	2000000
24,10	3224000
30,6	2730000
30,0	1530000

From the above table, it can be inferred that the maximum Z value is 3224000 when

x=24; y=10

Therefore, if the company produces 24 units of automation tools and 10 units of industrial cranes in 65 days, it will be able to effectively meet the demand and also maximize the profit. The maximized profit from the above project is 32,24,000 for 65 days or 2 months.

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Method 2: Graphical Solution

Constraints input

variables	x	y			
values	0	0		0	
Coefficient	51000	200000			
	x	y	LHS		RHS
C1	1		0	≤	30
C2		1	0	≤	10
C3	10	15	0	≤	390

Solution obtained by excel solver

variables	x	y			
values	24	10		3224000	
Coefficient	51000	200000			
	x	y	LHS		RHS
C1	1		24	≤	30
C2		1	10	≤	10
C3	10	15	390	≤	390

The solution thus obtained through excel solver is

Maximum Z = 3224000

Where x = 24 and y = 10

Conclusion

The study aiming to determine the optimal production levels of an automation company such that the profit of a certain demand tenure is maximized. Through the application of the Linear Programming Technique, it is found that optimum production quantities are found to be 24 units of industrial tools and 10 units of Industrial Automation moving solutions. This optimized strategic approach is expected to maximize the profits to 32,24,000 rupees, thus demonstrating the application of Linear Programming Problem through simplex to solve everyday business problems.

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