CAREER POINT INTERNATIONAL JOURNAL OF RESEARCH

Career Point International Journal of Research (CPIJR)
©2022 CPIJR | Volume 2 | Issue 4 | ISSN : 2583-1895
April - June 2025 | DOI: https://doi.org/10.5281/zenodo.15815802

Applying Linear Programming for Preparation of Paneer Butter Masala for profit maximization

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Abstract:

Linear programming a powerful mathematical technique, finds practical applications in solving real-world problems efficiently. Among its various methods, Simplex methods, one of the common methods can be used to calculate some mathematics involved problems in daily life, providing an accurate solution that is restrained by the given information and data. The aim of the present research work is to use the simplex method of linear programming to find the maximum profit in the sale of Paneer Butter Masala. The target is to earn highest possible profit while minimum expenditure.

Keywords: Linear programming model, Simplex method, Decision variables, Optimal result, Excel.

Introduction:

Linear programming emerged as a significant mathematical discipline following the development of the simplex method by G. B. Dantzig. Its evolution has been closely tied to its applications in the field of economics and management, with Dantzig's initial motivation rooted in solving U.S. Air Force planning challenges. Over time, linear programming has continued to find extensive use in planning and scheduling tasks. Notably, the field's growth has been facilitated by advancements in computing technology, as only the most straightforward linear programming problems could be tackled without computer.

Linear programming is the name of a branch of applied mathematics that deals with solving optimization problems of a particular form. Linear programming problems consist of a linear

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cost function (consisting of a certain number of variables) which is to be minimized or maximized subject to a certain number of constraints. The constraints are linear inequalities of the variables used in the cost function. The cost function is also sometimes called the objective function. Linear programming is closely related to linear algebra; the most noticeable difference is that linear programming often uses inequalities in the problem statement rather than equalities.

In the present work, the linear programming model is used for making paneer butter masala for highest possible profit in minimum expenditure.

General Form of a Linear Programming Model:

The general form of linear programming problem is

Optimize (Maximize or Minimize)

$$Z = c_1x_1 + c_2x_2 + \ldots + c_nx_n \text{ (objective function)} \qquad \ldots. (1.1)$$

Subject to the constraints

$a_{11}x_1 + a_{12}x_2 + \ldots. + a_{1n}x_n\ (<,=,>)b_1$

$a_{21}x_1 + a_{22}x_2 + \ldots. + a_{2n}x_n\ (\leq,=,\geq)b_2$

$$\ldots.. \quad \ldots.. \quad \ldots. \quad \ldots.. \quad \ldots.. \qquad \ldots. (1.2)$$

$$\ldots.. \quad \ldots.. \quad \ldots. \quad \ldots.. \quad \ldots..$$

$a_{m1}x_1 + a_{m2}x_2 + \ldots. + a_{mn}x_n\ (<,=,>)b_m$

and non-negative restrictions

$X_j \geq 0, \quad j = 1,2 \ldots n$

Where a_{ij}'s, b_i, s and c_j's are constants and xj 's are variables.

In the conditions given by (1.2) there may be any of the three signs $\leq, =, \geq$.

Standard form of a Linear programming problem for solving by simplex method is as

(a) Using slack and surplus variables to express all constraints as equation.

(b) For each constraints all $b_i \geq 0$, if any b_i is negative then multiply the corresponding constraint by − 1.

(c) Always, problem must be of maximization type, if not, convert it in maximization type by multiplying objective function by −1.

Using slack and surplus variables the linear programming problem of n variables and m constraints can be written as follows:

Optimize

$$Z = c_1 x_1 + c_2 x_2 + \dots + c_n x_n + 0.s_1 + 0.s_2 + \dots + 0.s_m \text{ (Objective function)} \qquad \dots (1.3)$$

Subject to the constraints

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n + s_1 &= b_1 \\ a_{21}x_1 + a_{22}x_2 + \dots + a_{2n}x_n + s_2 &= b_2 \\ \dots \quad \dots \quad \dots \quad \dots \quad & \dots \\ \dots \quad \dots \quad \dots \quad \dots \quad & \dots \\ a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mn}x_n + s_m &= b_m \end{aligned} \qquad \dots (1.4)$$

and non – negative restrictions

$X_j \geq 0,\ s_i \geq 0,\ j = 1, 2 \dots n,\ i = 1, 2 \dots, m$

Where a_{ij}'s, b_i's and c_j's are constants and x_j's and s_i's are variables.

Review of Literature:

Taha (2017) outlines the core concepts of linear programming (LP) and highlights its practical use in business, particularly in enhancing manufacturing efficiency. He emphasizes how LP supports optimal resource allocation, resulting in reduced costs and increased profits. Industries like textiles, automotive, and furniture manufacturing have effectively utilized LP to improve production and profitability.

Charnes and Cooper (1950) were pioneers in showcasing the potential of LP for business applications. Their influential work demonstrated how LP techniques can be used to make efficient decisions regarding resource distribution and profit maximization, laying the groundwork for future developments in operations research.

In a more recent study, Sasongko Tri Utom and Wisnu Mawardi (2024) employed Data Envelopment Analysis (DEA) to evaluate the efficiency of coffee shops. They considered input factors such as labor expenses, cost of raw materials, total capital, and workforce size, while outputs included gross and net profits.

Overall, the reviewed literature confirms that LP is an effective approach for addressing production optimization challenges, especially in profit-focused manufacturing environments. Tools like Excel Solver have further simplified LP problem-solving, enabling

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small and medium-sized enterprises to enhance their operational strategies efficiently.

Assumption for problem:

➢ The efficient allocation of twelve ingredients plays a crucial role in the optimal production of paneer butter masala, contributing directly to maximizing the restaurant's profit.

➢ The strategic distribution of ingredients among the variables involved in paneer butter masala production is presumed to enhance efficiency, thereby optimizing the manufacturing process while simultaneously boosting the restaurant's profitability.

➢ Assumptions are made regarding the standard quality of ingredients utilized in the preparation of paneer butter masala, underlining the importance of consistency and reliability in the production process.

The assumed data of the problem is given as follows:

INGREDIENTS	**PRODUCTS**			**Total availability of material**
	500gm	1 Kg	2Kg	
Paneer(kg)	0.25	0.5	1	20kg
Groundnut Oil(L)	0.03	0.05	0.09	100
Tomatoes (kg)	0.2	0.4	0.8	50
Onions (kg)	0.4	0.8	1.2	70
Ginger- Garlic Paste (g)	15 (1 tbsp)	30 (2 tbsp)	60 (4 tbsp)	500
Butter (kg)	0.03 (2 tbsp)	0.05 (4 tbsp)	0.12 (8 tbsp)	5
Cream (kg)	0.06 (4 tbsp)	0.12 (8 tbsp)	0.24 (16 tbsp)	5
Cashew Nuts (kg)	0.05	0.1	0.2	5
Red chili powder (kg)	0.024 (2 tbsp)	0.048 (4 tbsp)	0.072 (6tbsp)	10

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Garam Masala (kg)	0.012 (1 tbsp)	0.024 (2 tbsp)	0.048 (4 tbsp)	5
Kasuri Methi (kg)	0.004 (2 tbsp)	0.008 (4 tbsp)	0.012 (6 tbsp)	5
Salt (kg)	0.0015 (1 tbsp)	0.03 (2 tbsp)	0.06 (4 tbsp)	10
Profit (Rupees)	100	150	250	

Model formulation:

Let the amount of 500 gm paneer butter masala to be made = x_1

Let the amount of 1 kg paneer butter masala to be made = x_2

Let the amount of 2 kg paneer butter masala to be made = x_3

Let Z mean the profit to be increased.

The L.P model for the above composition data is stated by-

Max $Z = 100x_1 + 150x_2 + 250x_3$

subject to

$0.25x_1 + 0.5x_2 + x_3 \leq 20$

$0.03x_1 + 0.05x_2 + 0.09x_3 \leq 100$

$0.2x_1 + 0.4x_2 + 0.8x_3 \leq 50$

$0.4x_1 + 0.8x_2 + 1.2x_3 \leq 70$

$15x_1 + 30x_2 + 60x_3 \leq 500$

$0.03x_1 + 0.05x_2 + 0.12x_3 \leq 5$

$0.06x_1 + 0.12x_2 + 0.24x_3 \leq 5$

$0.05x_1 + 0.1x_2 + 0.2x_3 \leq 5$

$0.024x_1 + 0.048x_2 + 0.072x_3 \leq 10$

$0.012x_1 + 0.024x_2 + 0.048x_3 \leq 5$

$0.004x_1 + 0.008x_2 + 0.012x_3 \leq 5$

$0.0015x_1 + 0.03x_2 + 0.06x_3 \leq 10$

$x_1, x_2, x_3 \geq 0.$

The above linear programming model was solved by EXCEL, which gives an optimal

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solution of: $x_1 = 33$, $x_2 = 0$, $x_3 = 0$ and maximum Z = 3334.

Interpretation of Result

Based on the data collected the optimum result derived from the LP model indicates that 500 gm paneer butter masala should be produced. Their production quantities should be 33 units respectively. This will produce a maximum profit of Rs. 3334.

Conclusion:

In light of the examination did in this investigation work and the outcome appeared, ratan vegetable and fruit shop, shree ji Kirana Store and Nama restaurant should sell the paneer butter masala packets with the end goal to fulfil clients. Additionally, a greater amount of 500g of paneer masala ought to be created with the end goal to achieve most extreme benefit, since they contribute for the most part to the benefit earned by the restaurant.

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April - June 2025 | DOI: https://doi.org/10.5281/zenodo.15815802

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