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# Application of Linear Programming for Profit Maximization in a Newly Established Furniture Manufacturing Business

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**Abstract:**

This research presents a linear programming (LLP) model to maximize profit in a newly established furniture manufacturing business based in Kota, India. The study is grounded in detailed market research, which identified the exact raw materials, quantities, and labor required to manufacture a wide range of furniture products including almirahs, beds, dining tables, sofas. Realistic cost data for each input and observed market selling prices were gathered to build an accurate cost-profit framework. The model aims to assist business owners in making data-driven production decisions by optimally allocating limited resources such as raw material inventory, labor, and capital to maximize overall profit. Constraints such as available quantities of teak wood, plywood, polish, and skilled labor were incorporated into the LLP formulation. The results demonstrate the practical application of operations research in the furniture sector, offering a scalable decision-making tool for entrepreneurs and manufacturers. This paper highlights the potential of mathematical modeling in guiding resource optimization and strategic planning in the small-scale manufacturing industry.

**Keywords:** Linear Programming, Profit Maximization, Furniture Manufacturing, Production Optimization

## Introduction:

In the early stages of a manufacturing business, especially in highly competitive sectors like furniture production, decision-makers are often confronted with the challenge of efficiently utilizing limited resources such as labor, raw materials, machinery, and capital. The ability to make informed and optimized production decisions becomes critical to ensure profitability and long-term sustainability. In such contexts, Linear Programming (LP) emerges as a powerful mathematical tool that supports optimal decision-making by modeling real-world constraints and objectives.

Linear Programming enables businesses to formulate and solve problems related to resource allocation, production scheduling, and product mix selection by maximizing or minimizing a specific objective function—most commonly, profit. Its strength lies in providing clear, data-driven insights into how businesses can operate most efficiently within defined limitations. For newly established furniture manufacturing businesses, which often operate under stringent budget and resource conditions, LP can offer strategic guidance for achieving the highest possible returns with available inputs.

The furniture manufacturing industry is characterized by a diverse product range, variability in demand, and resource-intensive operations. Applying LP in this context allows businesses to evaluate multiple production combinations and select the most profitable product mix while adhering to material availability, labor capacity, and time constraints. Furthermore, integrating LP techniques into the early decision-making process enhances cost control, reduces operational waste, and strengthens competitive positioning in the market.

This paper aims to develop and apply a linear programming model tailored to a start-up furniture manufacturing business with the objective of maximizing profit. The study involves identifying relevant constraints, formulating the LP model, solving it using appropriate optimization tools, and interpreting the results to derive practical recommendations for efficient production planning and strategic growth.

**Generalized Model of Linear Programming Problem**

Objectiv Function:

Maximize or Minimize (Z) = $c_1x_1 + c_2x_2 + \ ... + c_nx_n$

Subject to constraints:

$$a_{11}x_1 + a_{12}x_2 + \ ... + a_{1n}x_n \ \leq / = / \geq \ b_1$$

$$a_{21}x_1 + a_{22}x_2 + \ ... + a_{2n}x_n \ \leq / = / \geq \ b_2$$

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$$a_{m1}x_1 + a_{m2}x_2 + \ ... + a_{mn}x_n \ \le / = / \ge \ b_m$$

Non-negativity constraints:

$$x_1, x_2, \dots, x_n \ \ge \ 0$$

Where:

- $Z$ is the objective function
- $x_1, x_2, \dots, x_n$ are decision variables
- $c_i$ are coefficients of the objective function
- $a_{ij}$ are coefficients of the constraints
- $b_i$ are the right-hand side values of the constraints

This model helps in determining the best possible value of decision variables that optimize the objective while satisfying all given constraints.

**Review of Literature:**

Linear Programming (LP) has been widely applied across industries for optimal resource allocation and profit maximization. The foundational concepts of LP are detailed in classical texts such as Taha (2017) and Hillier & Lieberman (2010), which provide a theoretical framework for solving optimization problems involving constraints and objectives in production and operations.

A key study directly relevant to this paper is by Saxena and Sharma (2025), who applied LP to a furniture manufacturing unit to determine the optimal allocation of raw materials and labor. Their research demonstrated a significant increase in profitability through strategic product mix planning, emphasizing the practical applicability of LP in a resource-constrained environment. Similarly, Uddin et al. (2020) presented a case study that optimized material usage and production schedules in a furniture factory, confirming LP's effectiveness in improving cost efficiency and minimizing waste.

Complementary work by Al-Barrak and Al-Khursani (2018) focused on optimizing wood-cutting operations using LP, highlighting its role in maximizing yield from raw materials in wood-based industries. Their model is particularly useful in contexts like furniture manufacturing, where material dimensions and cutting patterns directly affect cost and waste.

Beyond furniture, LP has been employed in other manufacturing sectors. Ghosh and De (2015) applied LP in a chemical plant to balance raw material inputs against production constraints, while Singh and Kumar (2019) optimized profit in a textile firm by adjusting production volumes of different product lines. These studies reinforce LP's utility in determining optimal strategies under limited resources.

For small businesses and startups, LP also proves valuable. Sharma and Sinha (2018) applied it to a bakery startup to derive the most profitable product mix, and Khoshnevis and Amoozegar (2015) emphasized its strategic role in early-stage decision-making. These cases show how LP supports entrepreneurs in managing costs, resources, and demand uncertainties.

Tools for implementing LP models are discussed by Ragsdale (2014), who promotes spreadsheet-based optimization for managerial decision-making. His work is especially useful for small businesses that may lack access to advanced software but can still benefit from LP using platforms like Excel Solver.

In summary, the literature affirms that Linear Programming is a versatile and effective tool for optimizing production and profitability. In the specific context of furniture manufacturing, its ability to balance raw material use, labor allocation, and market demand makes it particularly valuable. The current study builds on these foundations, applying LP to a new furniture business to develop an optimal production plan that maximizes profit under real-world constraints.

**Problem Assumption**

Let us suppose someone wants to establish a new furniture manufacturing business. One of the main challenges they face is how to allocate limited resources—like raw materials, labor, and time—while ensuring maximum profitability. Following is the data of items to be manufactured with their cost of production. The data has been collected through extensive market research in Kota market, price may differ place to place. (Prices are inclusive of Labour charges). All the cost are in INR.

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| S.No | Product | Type | Raw Material Requirements | Qty Required | Unit | Cost per unit | Cost of raw material |
|---|---|---|---|---|---|---|---|
| **1** | **Almirah** | **2 door** | Plywood (8x4 ft) | 2 | sheets | 2400 | 4800 |
| | | | Hinges | 4 | pieces | 100 | 400 |
| | | | Handles | 2 | pieces | 36 | 72 |
| | | | Screws | 20 | pieces | 3 | 60 |
| | | | Polish/Varnish | 0.5 | litre | 400 | 200 |
| | | | Nails | 0.1 | kg | 70 | 7 |
| | | | Glue | 0.25 | litre | 250 | 62.5 |
| | | | | | | **Total Cost** | **5601.5** |
| **2** | **Almirah** | **3 door** | Plywood (8x4 ft) | 3 | sheets | 2400 | 7200 |
| | | | Hinges | 6 | pieces | 100 | 600 |
| | | | Handles | 3 | pieces | 36 | 108 |
| | | | Screws | 30 | pieces | 3 | 90 |
| | | | Polish/Varnish | 1 | litre | 400 | 400 |
| | | | Nails | 0.15 | kg | 70 | 10.5 |
| | | | Glue | 0.5 | litre | 250 | 125 |
| | | | | | | **Total Cost** | **8533.5** |
| **3** | **Almirah** | **4 door** | Plywood (8x4 ft) | 4 | sheets | 2400 | 9600 |
| | | | Hinges | 8 | pieces | 100 | 800 |
| | | | Handles | 4 | pieces | 36 | 144 |

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|---|---|---|---|---|---|---|---|
| | | | Screws | 40 | pieces | 3 | 120 |
| | | | Polish/Varnish | 1.5 | litre | 400 | 600 |
| | | | Nails | 0.2 | kg | 70 | 14 |
| | | | Glue | 0.75 | litre | 250 | 187.5 |
| | | | | | | **Total Cost** | **11465.5** |
| **4** | **Single bed** | | Plywood (8x4 ft) | 3 | sheets | 2400 | 7200 |
| | | | Teak wood | 2 | cu feet | 2000 | 4000 |
| | | | Hinges | 4 | pieces | 100 | 400 |
| | | | chest Handles | 2 | pieces | 70 | 140 |
| | | | Screws | 30 | pieces | 3 | 90 |
| | | | Polish/Varnish | 1 | litre | 400 | 400 |
| | | | Nails | 0.15 | kg | 70 | 10.5 |
| | | | Glue | 0.5 | litre | 250 | 125 |
| | | | | | | **Total Cost** | **12365.5** |
| **5** | **Double bed** | **Type 1** | Plywood (8x4 ft) | 4 | sheets | 2400 | 9600 |
| | | | Teak Wood (for frame, cu ft) | 3 | cu feet | 2000 | 6000 |
| | | | Hinges | 4 | pieces | 100 | 400 |
| | | | Handles | 2 | pieces | 70 | 140 |
| | | | Screws | 40 | pieces | 3 | 120 |
| | | | Polish/Varnish | 1.5 | litre | 400 | 600 |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Nails | 0.2 | kg | 70 | 14 |
| | | | Wood Adhesive (Fevicol) | 0.75 | litre | 250 | 187.5 |
| | | | | | | **Total Cost** | **17061.5** |
| **6** | **Double bed** | **Type 2** | Plywood (8x4 ft) | 4 | sheets | 2400 | 9600 |
| | | | Teak Wood (for frame, cu ft) | 3.5 | cu feet | 2000 | 7000 |
| | | | Hinges | 4 | pieces | 100 | 400 |
| | | | Handles | 2 | pieces | 70 | 140 |
| | | | Screws | 50 | pieces | 3 | 150 |
| | | | Polish/Varnish | 2 | litre | 400 | 800 |
| | | | Nails | 0.25 | kg | 70 | 17.5 |
| | | | Wood Adhesive (Fevicol) | 1 | litre | 250 | 250 |
| | | | | | | **Total Cost** | **18357.5** |
| **7** | **Dinning Table** | **4 seater** | Plywood (8×4 ft) | 1 | sheets | 2400 | 2400 |
| | | | Teak Wood (for frame & legs) | 3 | cu feet | 2000 | 6000 |
| | | | Screws | 30 | pieces | 3 | 90 |
| | | | Nails | 0.2 | kg | 70 | 14 |
| | | | Polish/Varn | 1.5 | litre | 400 | 600 |

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|---|---|---|---|---|---|---|---|
| | | | ish | | | | |
| | | | Wood Adhesive (Fevicol) | 0.75 | litre | 250 | 187.5 |
| | | | | | | **Total Cost** | **9291.5** |
| **8** | **Dinning Table** | **6 seater** | Plywood (8×4 ft) | 1.5 | sheets | 2400 | 3600 |
| | | | Teak Wood (for frame & legs) | 3.5 | cu feet | 2000 | 7000 |
| | | | Screws | 30 | pieces | 3 | 90 |
| | | | Nails | 0.2 | kg | 70 | 14 |
| | | | Polish/Varnish | 2 | litre | 400 | 800 |
| | | | Wood Adhesive (Fevicol) | 1 | litre | 250 | 250 |
| | | | | | | **Total Cost** | **11754** |
| **9** | **Sofa (A)** | **6 seater** | Teak Wood | 5 | cu feet | 2000 | 10000 |
| | | | Plywood | 1 | sheet | 2400 | 2400 |
| | | | Foam (32 Density) | 42 | sq ft | 160 | 6720 |
| | | | Fabric 1 (Upholstery) | 12 | mtrs | 450 | 5400 |
| | | | Fabric 2 (Accent) | 3 | mtrs | 580 | 1740 |
| | | | Nails | 0.3 | kg | 70 | 21 |

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|---|---|---|---|---|---|---|---|
| | | | Screws (Mixed) | 40 | pieces | 3 | 120 |
| | | | Wood Polish & Paint | 0.5 | litre | 400 | 200 |
| | | | Adhesive (Fevicol) | 1.5 | litre | 250 | 375 |
| | | | | | | **Total Cost** | **26976** |
| **10** | **Sofa (B)** | **6 seater** | Teak Wood | 3.5 | cu ft | 2000 | 7000 |
| | | | Plywood | 1 | sheet | 2400 | 2400 |
| | | | Foam (32 Density) | 36 | sq ft | 160 | 5760 |
| | | | Fabric 1 (Upholstery) | 10 | mtr | 450 | 4500 |
| | | | Nails | 0.75 | kg | 70 | 52.5 |
| | | | Screws | 40 | pcs | 3 | 120 |
| | | | Wood Polish | 0.25 | litre | 400 | 100 |
| | | | Adhesive (Fevicol) | 1 | kg | 250 | 250 |
| | | | | | | **Total Cost** | **20182.5** |

Cost of Labor is as follows:

| | Qty | Avg Salary | Total salary |
|---|---|---|---|
| Carpenter | 8 | 18000 | 144000 |
| Helpers | 2 | 7000 | 14000 |
| | | **Total Expense** | **158000** |

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Based on our production cost we have decided selling price for each product and based on market research, the demand for each product lies between the given range as follows:

| | Product | Types | Market Demand | Cost price | Selling price | Margins |
|---|---|---|---|---|---|---|
| x1 | Almirah | 2 door | 10-15 | 5,601 | 11,000 | 5,399 |
| x2 | | 3 door | 5-10 | 8,533 | 16,000 | 7,467 |
| x3 | | 4 door | 2-10 | 11465 | 18000 | 6535 |
| x4 | Single Bed | With | 3-10 | 12,365 | 17,500 | 5,135 |
| x5 | Double Bed | Type 1 | 10-15 | 17,061 | 25,000 | 7,939 |
| x6 | | Type 2 | 4-10 | 18,357 | 29,500 | 11,143 |
| x7 | Dining Table | 4-seater | 3-5 | 9,291 | 18,500 | 9,209 |
| x8 | | 6-seater | 1-3 | 11754 | 21500 | 9746 |
| x9 | Sofa | Type 1 | 5-12 | 26,976 | 35,000 | 8,024 |
| x10 | | Type 2 | 6-15 | 20,182 | 29,500 | 9,318 |

Available raw material (Inital Investement):

| Material | Cost/Unit (INR) | Unit | Qty | Price |
|---|---|---|---|---|
| Teak Wood | 2000 | cu feet | 350 | 700000 |
| Plywood (MR/BWR) | 2400 | sheet | 300 | 720000 |
| Foam (32 density) | 190 | sq feet | 1000 | 190000 |
| Fabric 1 | 450 | mtr | 200 | 90000 |
| Fabric 2 | 580 | mtr | 90 | 52200 |
| Wood Polish & Paint | 400 | litre | 1000 | 400000 |
| Adhesive | 250 | KG | 100 | 25000 |
| Misc (Nails, screws, handles) | | | | 10000 |

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| | | | | |
|---|---|---|---|---|
| | | | **Total Expense** | **2187200** |

**Model Formulation**

Let

$x_1$= Number of 2 door Almirah

$x_2$= Number of 3 door Almirah

$x_3$= Number of 4 door Almirah

$x_4$= Number of Single Bed

$x_5$= Number of Double Bed of type 1

$x_6$= Number of Double Bed of type 2

$x_7$= Number of Dinning Table 4 seater

$x_8$= Number of Dinning Table 6 seater

$x_9$= Number of Sofa of type 1

$x_{10}$= Number of Sofa of type 2

**Max Z =** $5399x_1 + 7467x_2 + 6535x_3 + 5135x_4 + 7939x_5 + 11143x_6 + 9209x_7 + 9746x_8 + 8024x_9 + 9318x_{10}$

**Subject to:**

$\mathbf{2x_1 + 3x_2 + 4x_3 + 3x_4 + 4x_5 + 4x_6 + x_7 + 1.5x_8 + x_9 + x_{10} \leq 100}$ **(Plywood Constraint)**

$2x_4 + 3x_5 + 3.5x_6 + 3x_7 + 3.5x_8 + 5x_9 + 3.5x_{10} \leq 350$ **(Teakwodd Constraint)**

$\mathbf{0.25x_1 + 0.5x_2 + 0.75x_3 + 0.5x_4 + 0.75x_5 + x_6 + 0.75x_7 + x_8 + 1.5x_9 + x_{10} \leq}$

**100 (Adhesive Constraint)**

$\mathbf{0.5x_1 + x_2 + 1.5x_3 + x_4 + 1.5x_5 + 2x_6 + 1.5x_7 + 2x_8 + 0.5x_9 + 0.25x_{10} \leq 100}$ **(Polish Constraint)**

$\mathbf{42x_9 + 36x_{10} \leq 1000}$ **(Foam Constraint)**

$\mathbf{12x_9 + 10x_{10} \leq 200}$ **(Fabric 1 Constraint)**

$\mathbf{3x_9 \leq 90}$ **(Fabric 2 Constraint)**

$\mathbf{10 \leq x_1 \leq 15}$ **(2 Door Almirah Demand)**

$\mathbf{5 \leq x_2 \leq 10}$ **(3 Door Almirah Demand)**

$\mathbf{2 \leq x_3 \leq 10}$ **(4 Door Almirah Demand)**

$\mathbf{3 \leq x_4 \leq 10}$ **(Single Bed Demand)**

$\mathbf{10 \leq x_5 \leq 15}$ **(Double Bed Demand type 1)**

$\mathbf{4 \leq x_6 \leq 10}$ **(Double Bed Demand type 2)**

$\mathbf{3 \leq x_7 \leq 5}$ **(Dinning Table 4 Seater Demand)**

$\mathbf{1 \leq x_8 \leq 3}$ **(Dinning Table 4 Seater Demand)**

$\mathbf{5 \leq x_9 \leq 12}$ **(Sofa Type 1 Seater Demand)**

$\mathbf{6 \leq x_{10} \leq 15}$ **(Sofa Type 2 Seater Demand)**

The above model was solved using Lingo 21.0 Software and the following result was obtained:

$x_1$= 15;$x_2$= 10;$x_3$= 7; $x_4$= 10; $x_5$= 15; $x_6$= 10; $x_7$= 5; $x_8$= 3; $x_9$= 5; $x_{10}$= 14

Max Z = 7,29,120 Rs.

Therefore, the results suggest that manufacturing 15 units of 2-door almirahs, 10 of 3-door almirahs, 7 of 4-door almirahs, 10 single beds, 15 double beds (type 1), 10 double beds (type 2), 5 dining tables (4-seater), 3 dining tables (6-seater), 5 sofas (type 1), and 14 sofas (type 2) would yield a maximum profit of ₹7,29,120.

**Conclusion:**

This study applied Linear Programming to optimize production and maximize profit in a furniture manufacturing business. Using LINGO 21.0, the model suggested an optimal product mix that generated ₹20,41,000 in sales. Out of the initial raw material investment of ₹21,87,200, only ₹13,11,880 was used, leaving materials worth ₹8,75,320 for future production. With a labor cost of ₹1,58,000, the net profit amounted to ₹5,71,120. These results highlight the effectiveness of Linear Programming in resource utilization and profit maximization.

**Future Scope:**

In continuation of this study, we plan to apply the Assignment Problem to allocate specific tasks to available labor more efficiently. This approach aims to ensure optimal utilization of the workforce, reduce idle time, and further enhance overall profitability in the furniture manufacturing process.

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