**SCM 518**

**FINAL PROJECT REPORT**

**Optimizing Construction Planning for Profit Maximization: YUVA INFRA**

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# **Background:**

YUVA Infra, a renowned construction company based in Hyderabad, India, specializes in developing apartments, individual houses, and commercial spaces across Telangana, Andhra Pradesh, and Karnataka. With a focus on modern urban living, the company offers a diverse project portfolio to meet varied market demands and customer preferences.

YUVA Infra's clientele includes real estate agents, individual buyers, corporate offices, and government agencies, particularly drawn to their commercial constructions. The company's pricing strategy varies per square foot, reflecting market dynamics and client preferences.

The company's cost structure includes material, labor, machinery, and land costs. These costs are crucial for project profitability, with a focus on competitive pricing and quality maintenance. YUVA Infra's operational strategy involves key constraints such as construction mix, sales quotas, and size distribution.

Overall, YUVA Infra's approach is tailored to meet diverse customer needs while ensuring steady sales and profitability, aligning with their central goal of refining construction and sales strategies for maximum profitability.

A significant challenge for YUVA Infra, as with any construction company, is the management of its budget. With a total construction budget of ₹3,500,000,000, the company must meticulously plan and allocate its resources to maximize efficiency and profitability.

## **Scenario Details:**

**Types of Constructions and Their Sizes**:

|  |  |  |
| --- | --- | --- |
| **Type** | **Size** | **Avg SQFT** |
| Apartment | Small | 900 |
|  | Medium | 1400 |
|  | Large | 2100 |
| Individual Houses | Small | 1200 |
|  | Medium | 1700 |
|  | Large | 2700 |
| Commercial Buildings | Small | 2500 |
|  | Medium | 3500 |
|  | Large | 5000 |

**Clients:**

The Clients for Yuva Infra typically include:

- Real Estate Agents

- Individual Buyers

- Offices (only interested in commercial spaces)

- Government Agencies (only interested in commercial spaces)

**Pricing Structure** (per sq ft):

Selling Prices vary depending on the type of client or buyer.

All prices are per square foot.

|  |  |  |
| --- | --- | --- |
| **Construction Type** | **Buyer** | **Selling Price** |
| Apartment | Real estate agent | 6000 |
| Apartment | Individual owner | 6200 |
| Individual house | Real estate agent | 6900 |
| Individual house | Individual owner | 7200 |
| Commercial building | Real estate agent | 7800 |
| Commercial building | Individual owner | 8400 |
| Commercial building | Government agencies | 7200 |
| Commercial building | Corporate offices | 8400 |

**Costs** (per sq ft):

Costs typically include raw material cost, labor cost (mostly human labor), Machinery Cost and most importantly Land Cost.

All costs are per square foot.

|  |  |
| --- | --- |
| **Type of Cost** | **Cost per SQFT** |
| Material Cost | 800 |
| Labor Cost | 950 |
| Machinery Cost | 500 |
| Land Cost | 3000 |

**Construction Mix:**

This indicates the minimum percentage of a type of construction to be built. This is based on general market demands for each of these construction types.

|  |  |
| --- | --- |
| **Construction type** | **Minimum** |
| Apartments | 20% |
| Individual Houses | 15% |
| Commercial Spaces | 25% |

**Sales Quotas**:

|  |  |  |  |
| --- | --- | --- | --- |
| **Construction Type** | **Buyer** | **Minimum** | **Maximum** |
| Apartment | Real estate agent | 10 | 50 |
| Apartment | Individual owner | 10 | 50 |
| Individual house | Real estate agent | 5 | 40 |
| Individual house | Individual owner | 5 | 40 |
| Commercial building | Real estate agent | 15 | 40 |
| Commercial building | Individual owner | 15 | 40 |
| Commercial building | Government agencies | 15 | 40 |
| Commercial building | Corporate offices | 15 | 40 |

**Size Distribution**:

- At least 15% small, 40% medium, and 25% large constructions.

How many constructions that should be built per each size. These numbers are based on general market demands of each type.

|  |  |
| --- | --- |
| **Construction size** | **Minimum** |
| Small | 15% |
| Medium | 40% |
| Large | 25% |

**Budget Limitation:**

- Total budget for construction: ₹3500000000.

**Task**

Develop an LP model to determine:

- The number of each type and size of construction to be built to allocate these constructions to various client types to maximize profit.

## **Questions to be addressed:**

1. What construction mix (type and size) should the company focus on to maximize profits?

2. How should the constructions be allocated among the different client types?

3. What are the key factors that influence the profitability in this scenario?

4. How does the budget constraint affect the construction planning and profit maximization?

# **Model Formulation:**

A mathematical model to address this problem looks like this:

## **Inputs:**

Indices:

* i {1,2,3} – representing construction type.
* eg: 1- Apartment, 3- Commercial Buildings
* j {s, m, l} – representing sizes of constructions.
* eg: s - small, m – medium, l – Large
* k {r, i, g, c} – representing type of clients.
* eg: r – real estate agents, g - government agencies

sqij = average square foot for construction type ‘i’ and size ‘j’.

* eg: sq1s = 900

pik = selling price of construction type ‘i’ to client ‘k’ per square foot.

* Eg: p1r = 6000 INR

r = raw material cost per square foot

l = labor cost per square foot

m = machinery cost per square foot

c = land cost per square foot

Ai = Minimum percentage of total constructions for type ‘i’.

* Eg: Ai = 0.2

Bj = Minimum percentage of total constructions for size ‘j’.

LLik = Minimum number of construction type ‘i’ that can be sold to client ‘k’.

ULik = Minimum number of construction type ‘i’ that can be sold to client ‘k’.

B = Maximum Budget

## **Decision Variables:**

Xijk = No. of units of construction type ‘i’ of size ‘j’ that can be sold to client ‘k’

## **Objective Function:**

Our objective is to Maximize Profit.

Max Xijk (ΣiΣk Pik ΣjsqijXijk) – (ΣiΣjsqij\*Σ k Xijk) (r+l+m+c)

## **Constraints:**

* LLik <= Σj Xijk <= ULik

No. of units of construction type ‘i’ sold to client ‘k’ must be within the specified maximum and minimum limits.

* (ΣiΣjsqij\*Σ k Xijk) (r+l+m+c) <= B

Total Cost should not exceed the Budget.

* Σj Σk Xijk >= Ai ΣiΣj Σk Xijk

Should meet the minimum percentage limit for different construction types.

* Σi Σk Xijk >= Bj ΣiΣj Σk Xijk

Should meet the minimum percentage limit for different sizes of construction.

* Xijk >= 0

Non- negative number of constructions.

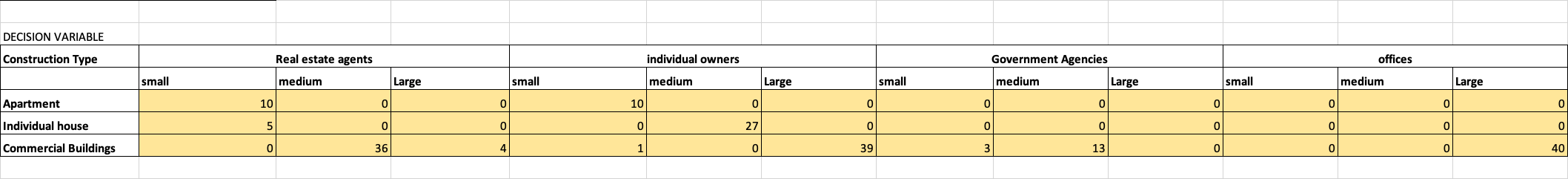
* Xijk = {integers}

Number of Constructions should be an integer value.

# **Solver Solutions:**

At an estimated profit of ₹1651425000, Solver allocates different construction types to different clients as follows:

* For apartments, 10 small units are allocated to real estate agents, and 20 small units are allocated to individual owners.
* For individual houses, 17 small units, 1 medium, and 22 large units are allocated to real estate agents, while 40 large units are allocated to government agencies.
* For commercial buildings, 15 large units are allocated to real estate agents, 20 large units to individual owners, 15 large units to government agencies, and 40 large units to corporate offices.

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A screenshot of a graph

Description automatically generated

# **Inferences:**

**1. Construction Mix Focus for Maximized Profits:**

* Commercial buildings are given priority, followed by Individual houses which suggests these constructions have higher profit margins or demand. Since individual houses range from small to large, the variety caters to a broader market, and the allocation of large units to government agencies could be due to their preferences or higher budgets. Commercial buildings, especially large ones, seem to be highly profitable, as indicated by the solver allocating significant quantities to all client types, particularly corporate offices.

**2. Allocation Among Client Types:**

* Apartments: Small units are allocated to both real estate agents and individual owners. This might be because the smaller units are quicker to sell or because there's a stronger market demand for them among these buyers.
* Individual Houses: A mix of small, medium, and large units is sold primarily to real estate agents, with a substantial allocation of large units to individual owners, which could be due to the premium prices these units can command.
* Commercial Buildings: Large units are prioritized across all types of clients, with the largest share going to corporate offices. This suggests that there's a high demand and willingness to pay a premium for large commercial spaces from businesses.

**3. Profitability Influencing Factors:**

* The selling price per square foot is higher for individual owners and corporate offices, which suggests targeting these clients could increase profits.
* The solver's allocation also respects the minimum construction mix percentages and the sales quotas, ensuring a diversified portfolio to mitigate risks related to market fluctuations.

**4. Effect of Budget Constraint:**

* The budget constraint directly limits the number of constructions that can be undertaken. The solver solution has maximized the allocation of constructions to the types and client categories that are most profitable within the budget.
* The solver solution provided indicates that the most profitable strategy within the given constraints is to focus on building individual houses and commercial buildings. These allocations are influenced by factors such as the high selling price from these client groups, along with the cost considerations for each construction type. The distribution of construction sizes also aligns with the market demand for larger spaces among certain client categories, indicating that this is where the company can find the most significant profit margins while staying within budget.

# **Conclusion:**

Yuva Infra should concentrate its efforts on the construction of individual houses and large commercial buildings, targeting individual owners and corporate clients to capitalize on their readiness to pay premium prices. The data indicates that focusing on these segments within the stipulated budget constraints ensures a higher profit margin, especially when leveraging the demand for larger units. By adhering to a strategic construction mix and sales quotas, the company can maintain a balanced portfolio that both meets market demand and maximizes profitability.