

QUANTITATIVE MANAGEMENT MODELING

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Assignment 1

Question 1:

A. Clearly define the decision variables:

"C" signifies the weekly production quantity of Collegiate backpacks, while "M" denotes the weekly production quantity of Mini backpacks.

B. What is the objective function?

The goal is to optimize the Total Profit (P) obtained from manufacturing both Collegiate and Mini backpacks. The objective function is to maximize P (Total Profit), which is represented as follows: Maximize P (Total Profit), where $P = 32C + 24M$

C. What are the constraints?

1. Material Limitation: Ensure that the combined square footage of nylon used does not surpass the available 5000 square feet per week.

- Constraint 1: $3C + 2M \leq 5000$

2. Collegiate Demand Constraint: The production of Collegiate backpacks must not exceed 1000 units per week.

- Constraint 2: $C \leq 1000$

3. Mini Demand Constraint: The production of Mini backpacks must not exceed 1200 units per week.

- Constraint 3: $M \leq 1200$

4. Labor Utilization Constraint: Ensure that the total labor hours utilized do not exceed the available labor hours (35 laborers, each providing 40 hours per week).

- Constraint 4: $45C + 40M \leq 35 * 40$

5. Non-negativity Requirement: The quantities of both types of backpacks produced must be non-negative.

- Constraint 5: $C \geq 0, M \geq 0$

D. Write down the full mathematical formulation for this LP problem.

The linear programming problem can be expressed as follows:

Objective Function: Maximize $P = 32C + 24M$

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Constraints:

- Material Constraint: $3C + 2M \leq 5000$
- Demand Constraint for Collegiate: $C \leq 1000$
- Demand Constraint for Mini: $M \leq 1200$
- Labor Constraint: $45C + 40M \leq 35 * 40$
- Non-negativity Constraint: $C \geq 0, M \geq 0$

This formulation aims to maximize Total Profit (P) while considering constraints related to material availability, demand, labor, and non-negativity.

Question 2:

A. Definition of Decision Variables:

In order to maximize the profits for Weigelt Corporation, we need to determine the quantity of the new product to be manufactured at each of the company's plants, regardless of the product size.

Key Definitions:

- X_i represents the number of units produced at each plant, where $i = 1$ (Plant 1), 2 (Plant 2), 3 (Plant 3).
- The product sizes are denoted as L for large, M for medium, and S for small.

Decision Variables:

- X_{iL} represents the number of large-sized items produced at plant i .
- X_{iM} represents the number of medium-sized items produced at plant i .
- X_{iS} represents the number of small-sized items produced at plant i .

B. Linear Programming Formulation for the Problem:

Objective:

Maximize the profit (Z) by producing different product sizes at each plant:

$$Z = 420(X_{1L} + X_{2L} + X_{3L}) + 360(X_{1M} + X_{2M} + X_{3M}) + 300(X_{1S} + X_{2S} + X_{3S})$$

Constraints:

1. Total number of each product size produced, regardless of the plant:

- $L = X_{1L} + X_{2L} + X_{3L}$
- $M = X_{1M} + X_{2M} + X_{3M}$

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- $S = X1S + X2S + X3S$

2. Production capacity constraints for each plant:

- Plant 1: $X1L + X1M + X1S \leq 750$

- Plant 2: $X2L + X2M + X2S \leq 900$

- Plant 3: $X3L + X3M + X3S \leq 450$

3. In-process storage constraints for each plant:

- Plant 1: $20X1L + 15X1M + 12X1S \leq 13,000$

- Plant 2: $20X2L + 15X2M + 12X2S \leq 12,000$

- Plant 3: $20X3L + 15X3M + 12X3S \leq 5,000$

4. Sales forecast constraints:

- Large Size: $L \leq 900$

- Medium Size: $M \leq 1,200$

- Small Size: $S \leq 750$

5. Non-negativity constraints:

- $XiL \geq 0$

- $XiM \geq 0$

- $XiS \geq 0$ (for $i = 1, 2, 3$)

6. Percentage utilization constraint:

To ensure the same percentage of excess capacity utilization for each plant, introduce a new decision variable, Y , and set it equal to the percentage of excess capacity used. The following equations ensure uniform excess capacity utilization across all three plants:

- $Y = (X1L + X1M + X1S) / 750$

- $Y = (X2L + X2M + X2S) / 900$

- $Y = (X3L + X3M + X3S) / 450$

These equations ensure that the percentage of excess capacity used is consistent for all three plants.