QUANTITATIVE MANAGEMENT MODELING

Assignment Module 2 – The LP Model

Question-1:

A. Decision Variables:

In this context, decision variables refer to the amounts of collegiate backpacks

(A) and mini backpacks (B) produced weekly.

Notation:

TP = Total Profit

A = Number of collegiate backpacks

B = Number of mini backpacks

B. Objective Function:

The idea of profit maximization is the main goal of the objective function. The profits of college backpacks are $32, while those from tiny backpacks are $24.

Objective:

Maximize (Profit) = 32A + 24B

C. Constraints:

Material Constraints: A 5,000 square feet of nylon fabric is easily available. Every little backpack requires 2 square feet, while college backpacks require 3 square feet.

Constraint: $3A + 2B \leq 5000$

Time Constraint: 35 workers work 40 hours each week. To make a profit of $25, mini backpacks need 40 minutes, while collegiate backpacks will make a profit of $32 in 45 minutes.

Constraint: 45A + 40B <= 35 employees * 40 hours * 60 minutes

Non-Negativity:

0 <= A <=1000

$0 <= B <= 1200$

D. Mathematical Formulation:

Let A = No. of collegiate backpacks produced per week

B = No. of mini backpacks produced per week

Maximize (Total Profit, Z) = 32A + 24B

Subject to:

$A \leq 1000$ (Weekly production limit for collegiate backpacks)

$B \leq 1200$ (Weekly production limit for mini backpacks)

$45A + 40B <= 84,000$ minutes per week (35 employees * 40 hours * 60 minutes)

$3A + 2B <= 5000$ sq. ft of material required per week.

Question-2:

A. Define the Decision Variables:

The decision variables are the amounts of the new product, irrespective of size, produced in each of the three factories.

Notation:

Xi = Number of units produced at each plant

i.e., i = 1 for (Plant 1), 2(Plant 2), 3(Plant 3)

L, M, and S = Product Sizes

where L = large, M = medium, S = small.

Decision Variables:

XiL = Number of units of large-sized items produced in Plant i

XiM = Number of units of medium-sized items made in Plant i

XiS = Number of units of small-sized items made in Plant i (for i = 1, 2, 3)

B. Formulate the Linear Programming Model:

Objective:

After analyzing results with varying scales in all three locations, the aim is to achieve the potential profit (Z).

X_iL = The quantity of large goods produced at plant i

X_iM = The number of medium-sized products manufactured at plant i

X_iS = It represents the quantity of small things generated on plant i.

where i = 1 (Plant 1), 2 (Plant 2), 3 (Plant 3).

Maximize profit:

$Z = 420 (X_1L + X_2L + X_3L) + 360 (X_1M + X_2M + X_3M) + 300 (X_1S + X_2S + X_3S)$

Constraints:

Total Units Produced for Each Size:

$L = X_1L + X_2L + X_3L$

$M = X_1M + X_2M + X_3M$

$S = X_1S + X_2S + X_3S$

Production Capacity Constraints for Each Plant:

Plant 1: $X_1L + X_1M + X_1S \leq 750$

Plant 2: $X_2L + X_2M + X_2S \leq 900$

Plant 3: $X_3L + X_3M + X_3S \leq 450$

Storage Capacity Constraints for Each Plant:

Plant 1: $20X_1L + 15X_1M + 12X_1S \leq 13,000$

Plant 2: $20X_2L + 15X_2M + 12X_2S \leq 12,000$

Plant 3: $20X_3L + 15X_3M + 12X_3S \leq 5,000$

Sales Forecast Constraints for Each Size:

$L = X_1L + X_2L + X_3L \leq 900$

$M = X_1M + X_2M + X_3M \leq 1200$

$S = X_1S + X_2S + X_3S \leq 750$

The extra capacity that is required to be provided by the factories to produce the new product is always constant, either or %.

$$\frac{X_1L + X_1M + X_1S}{750} = \frac{X_2L + X_2M + X_2S}{900} = \frac{X_3L + X_3M + X_3S}{450}$$

Utilization of Excess Capacity (Equal Percentage in All Plants):

$900(X_1L + X_1M + X_1S) - 750(X_2L + X_2M + X_2S) = 0$

$450(X_2L + X_2M + X_2S) - 900(X_3L + X_3M + X_3S) = 0$

$450(X_1L + X_1M + X_1S) - 750(X_3L + X_3M + X_3S) = 0$

Non-Negativity:

L, M, and S should be greater than or equal to zero.

XiL, XiM, and XiS should be greater than or equal to zero.