

Assignment : Module 2

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Course: QUANTITATIVE MANAGEMENT MODELING (MIS-64018-002)

1.

a. Clearly define the decision variables

Collegiate and Mini are decision variables

Let x_1 = Number of collegiate backpacks manufactured

x_2 = Number of Mini backpacks manufactured

Z = Total profit produced per week

b. What is the objective function?

Let Z be the Max profit,

$$Z = 32x_1 + 24x_2$$

c. What are the constraints?

Back Savers has a long term contract with a supplier of the nylon and receives a 5000 square foot shipment of the material each week. Each Collegiate requires 3 square feet while each Mini requires square feet.

$$3x_1 + 2x_2 \leq 5000$$

The sales forecasts indicate that at most 1000 Collegiates and 1200 Minis can be sold per week

$$x_1 \leq 1000, x_2 \leq 1200$$

Collegiate requires 45 minutes of labor

Mini requires 40 minutes of labor

Back Savers has 35 laborers that each provides 40 hours of labor per week

$$45/60x_1 + 40/60x_2 \leq 35 \times 40$$

$$3/4x_1 + 2/3x_2 \leq 1400$$

$$x_1 \geq 0, x_2 \geq 0$$

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

$$\text{Maximize } Z = 32x_1 + 24x_2$$

Subject to restrictions:

$$3x_1 + 2x_2 \leq 5000$$

$$x_1 \leq 1000, x_2 \leq 1200$$

$$\frac{3}{4}x_1 + \frac{2}{3}x_2 \leq 1400$$

And

$$x_1 \geq 0, x_2 \geq 0$$

2.

a. Define the decision variables

Let three plants be p_1, p_2, p_3

Three sizes of product be Large(l), Medium(m), Small(s)

Let, The Number of Large size products produced by plant 1 be p_{1l}

The Number of Medium size products produced by plant 1 be p_{1m}

The Number of Small size products produced by plant 1 be p_{1s}

The Number of Large size products produced by plant 2 be p_{2l}

The Number of Medium size products produced by plant 2 be p_{2m}

The Number of Small size products produced by plant 2 be p_{2s}

The Number of Large size products produced by plant 3 be p_{3l}

The Number of Medium size products produced by plant 3 be p_{3m}

The Number of Small size products produced by plant 3 be p_{3s}

Decision variables: $p_{1l}, p_{1m}, p_{1s}, p_{2l}, p_{2m}, p_{2s}, p_{3l}, p_{3m}, p_{3s}$

b. Formulate a linear programming model for this problem

Objective Function:

product can be made in three sizes large, medium, and small that yield a net unit profit of \$420, \$360, and \$300, respectively.

Let Z be the Max profit,

$$Z = 420(p_{1l} + p_{2l} + p_{3l}) + 360(p_{1m} + p_{2m} + p_{3m}) + 300(p_{1s} + p_{2s} + p_{3s})$$

Constraints:

Plants 1, 2, and 3 have the excess capacity to produce 750, 900, and 450 units per day of this product, respectively, regardless of the size or combination of sizes involved.

$$p_{1l} + p_{1m} + p_{1s} \leq 750$$

$$P2l + p2m + p2s \leq 900$$

$$P3l + p3m + p3s \leq 450$$

plants 1, 2, and 3 have 13,000, 12,000, and 5,000 square feet, respectively, of in process storage space available for a day's production of this product. Each unit of the large, medium, and small sizes produced per day requires 20, 15, and 12 square feet, respectively

$$20p1l + 15p1m + 12p1s \leq 13000$$

$$20p2l + 15p2m + 12p2s \leq 12000$$

$$20p3l + 15p3m + 12p3s \leq 5000$$

Sales forecasts indicate that if available, 900, 1,200, and 750 units of the large, medium, and small sizes, respectively, would be sold per day

$$p1l + p1m + p1s \leq 900$$

$$p2l + p2m + p2s \leq 1200$$

$$p3l + p3m + p3s \leq 750$$

To avoid layoffs if possible, management has decided that the plants should use the same percentage of their excess capacity to produce the new product.

$$750(p1l + p1m + p1s) - 900(p2l + p2m + p2s) = 0$$

$$900(p2l + p2m + p2s) - 450(p3l + p3m + p3s) = 0$$

$$450(p3l + p3m + p3s) - 750(p1l + p1m + p1s) = 0$$

$$p1l, p1m, p1s \geq 0$$

$$p2l, p2m, p2s \geq 0$$

$$p3l, p3m, p3s \geq 0$$

Formulating the problem,

$$\text{Maximize } Z = 420(p1l + p2l + p3l) + 360(p1m + p2m + p3m) + 300(p1s + p2s + p3s)$$

Subject to restrictions:

$$p1l + p1m + p1s \leq 750$$

$$p2l + p2m + p2s \leq 900$$

$$p3l + p3m + p3s \leq 450$$

$$20p1l + 15p1m + 12p1s \leq 13000$$

$$20p2l + 15p2m + 12p2s \leq 12000$$

$$20p_{3l} + 15p_{3m} + 12p_{3s} \leq 5000$$

$$p_{1l} + p_{1m} + p_{1s} \leq 900$$

$$p_{2l} + p_{2m} + p_{2s} \leq 1200$$

$$p_{3l} + p_{3m} + p_{3s} \leq 750$$

$$750(p_{1l} + p_{1m} + p_{1s}) - 900(p_{2l} + p_{2m} + p_{2s}) = 0$$

$$900(p_{2l} + p_{2m} + p_{2s}) - 450(p_{3l} + p_{3m} + p_{3s}) = 0$$

$$450(p_{3l} + p_{3m} + p_{3s}) - 750(p_{1l} + p_{1m} + p_{1s}) = 0$$

And

$$p_{1l}, p_{1m}, p_{1s} \geq 0$$

$$p_{2l}, p_{2m}, p_{2s} \geq 0$$

$$p_{3l}, p_{3m}, p_{3s} \geq 0$$