
Quantitative Management Modelling-Assignment 1 -part II

Topic: Mathematical formulation for LP problem

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2. Back Savers is a company that produces backpacks primarily for students. They are considering offering some combination of two different models—the Collegiate and the Mini. Both are made out of the same rip-resistant nylon fabric. Back Savers has a longterm 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 2 square feet. The sales forecasts indicate that at most 1000 Collegiates and 1200 Minis can be sold per week. Each Collegiate requires 45 minutes of labor to produce and generates a unit profit of $32. Each Mini requires 40 minutes of labor and generates a unit profit of $24. Back Savers has 35 laborers that each provides 40 hours of labor per week. Management wishes to know what quantity of each type of backpack to produce per week.

a. Clearly define the decision variables

b. What is the objective function?

c. What are the constraints?

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

Solution:

Let's consider no. of collegiate and mini backpacks company must produce be X1 and X2 respectively.

Since, each collegiate generates $32 per unit profit and $24 per unit from each mini backpack, total profit will be denoted by Z.

$$Z = \$(32X1 + 24X2)$$

As mentioned, each collegiate requires 3 square feet of nylon fabric and each mini backpack requires 2 square feet of nylon fabric, so the total nylon fabric required will be

$$3X1 + 2X2 \leq 5000$$

The sales forecast indicates at most 1000 collegiates and 1200 mini backpacks can be sold per week and they should not produce more of each backpack than the sales forecast. Therefore,

$$X1 \leq 1000$$

$$X2 \leq 1200$$

Total labor time required to produce X1 collegiate and X2 mini backpacks is (45X1 + 40X2) minutes.

Available labor time is 35*40*60 = 84000 minutes (No. of employees* hours per week*60 mins)

so, $45X1 + 40X2 \leq 84000$

Therefore, the mathematical problem should be defined as following:

The decision variables are:

X1 = number of collegiates
X2 = number of mini backpacks

Objective function is:

Maximize $Z = 32X1 + 24X2$

Constraints:

Subject to, $3X1 + 2X2 \leq 5000$

$$X1 \leq 1000$$

$$X2 \leq 1200$$

$$45X1 + 40X2 \leq 84000$$

and $X1, X2 \geq 0$