**QMM Assignment: Module 2 - The LP Model**

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1. Given,

Two different models—Collegiate and Mini

Nylon material - 5000 square-foot/week

Collegiate requires 3 square feet of Nylon material

Mini requires 2 square feet of Nylon material

Sales: 1000 Collegiates/week and 1200 Minis/week

Labor effort: Collegiate: 45 min, Mini: 40 min

Profit: Collegiate: $32, Mini: $24

1. Clearly define the decision variables

P: Total Profit

C: Total no. of Collegiates

M: Total no. of Minis

1. What is the objective function?

In theory, our objective is to maximize profits

P(C, M) = 32C + 24M

where C and M are our variables

Since we can't make negative backpacks, both C and M must be greater than 0

while both variables also have sales limits:

0≤C≤1000

0≤M≤1200

1. What are the constraints?

Given,

Collegiate requires 3 square feet of Nylon material

Mini requires 2 square feet of Nylon material

Total Nylon material - 5000 square-foot/week

Which implies:

3C+2M <= 5000

Collegiate produces 32$ profit and required 45 minutes labor.

Mini produces 24$ profit and required 40 minutes labor

Therefore, Profit P = 32C + 24M

Available labor is 35\*40 = 1400hours

Whereas Total labor required is (45C + 40M) minutes which is <= 1400 hours / week

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

C<= 1000

M<= 1200

And Variables must be greater than 0,

C, M >= 0

Our constraints are the amount of material we must work with each week and how many labor-hours there are each week. We have 5,000 square-foot of nylon and 35 x 40 = 1400 total labor-hours for making our backpacks:

5000≥3C+2M

1400≥3/4C+2/3M

1. Write down the full mathematical formulation for this LP problem?

P = 32C + 24M

3C+2M <= 5000

45C + 40M <= 1400hours

C<= 1000

M<= 1200

Therefore, C >= 0

M >= 0

1. a. Define the decision variables?

Decision Variables: In this case, the decision variables are the total number of units of the new product, not considering the product’s size, it should be produced on each plant to maximize the organization’s profit.

Yn = number of unit’s produced on each plant,

Where n = 1, 2, 3….

Product Size: L = large, M = medium, S = small.

Decision Variables:

YnL = Number of Large sized items produced on plant n

YnM = Number of Medium sized items produced on plant n

YnS = Number of Small sized items produced on plant n

Where n = 1, 2, 3….

b. Formulate a linear programming model for this problem?

Consider,

YnL = Number of Large sized items produced on plant n

YnM = Number of Medium sized items produced on plant n

YnS = Number of Small sized items produced on plant n

Where n = 1, 2, 3….

Maximize Profit

P = 420 (Y1L + Y2L + Y3L) + 360 (Y1M + Y2M + Y3M) +

300 (Y1S + Y2S + Y3S)

Constraints:

Total number of size’s units produced regardless the plant:

L = Y1L + Y2L + Y3L

M = Y1M + Y2M + Y3M

S = Y1S + Y2S + Y3S

Production Capacity per unit/day can be considered as,

Plant Number 1 = Y1L + Y1M + Y1S which is ≤ 750

Plant Number 2 = Y2L + Y2M + Y2S which is ≤ 900

Plant Number 3 = Y3L + Y3M + Y3S which is ≤ 450

Storage capacity per unit/day can be considered as,

Plant Number 1 = 20Y1L + 15Y1M + 12Y1S which is ≤ 13000

Plant Number 2 = 20Y2L + 15Y2M + 12Y2S which is ≤ 12000

Plant Number 3 = 20Y3L + 15Y3M + 12Y3S which is ≤ 5000

Sales/day can be considered as,

L = Y1L + Y2L + Y3L ≤ 900

M = Y1M + Y2M + Y3M ≤ 1200

S = Y1S + Y2S + Y3S ≤ 750

The main prerequisite to produce a new product, plants should use the same percentage of their excess capacity

Y1L + Y1M + Y1S = Y2L + Y2M + Y2S = Y3L + Y3M + Y3S

750 900 450

Simplified as:

a) 900 (Y1L + Y1M + Y1S) – 750 (Y2L + Y2M + Y2S) = 0

b) 450 (Y2L + Y2M + Y2S) – 900 (Y3L + Y3M + Y3S) = 0

c) 450 (Y1L + Y1M + Y1S) – 750 (Y3L + Y3M + Y3S) = 0

Since negative products cannot be produced, all the values must be either zero or greater than 0 which concludes,

L, M and S ≥ 0

YnL, YnM and YnS ≥ 0