QUANTITATIVE MANAGEMENT MODELING (MIS-64018-002)

Module 2 - The LP Model

• Formulate a linear program model for different scenarios

1. 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 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 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

	S	Time.	Profit
Collegiate	3.	45.	32$
Mini	2	40.	24$

35labours = 40 hrs each

a) Clearly define the decision variables

Decision variables

Collegiate =x

Mini = y

b) . What is the objective function?

Objective function

Maximize profit   z= 32x + 24 y

c). What are the constraints?

Labour constraints: 45x + 40y < (35) (40)(60)

Material constraints: 3x + 2y < 5000

No Negativity

X,Y>0

X<1000

Y<1200

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

Z =32 X+24Y (maximize)

45x+40y < (35)(40)(60)

3x+2y<5000

Explanation

Since each collegiate generates $30 and each mini generates $22 profit so total profit is

$Z = (30x+22y)$

So, each collegiate required 2.5 sq ft and mini requires 1.5 sqft of nylon fabric, so total nylon fabric required (2.5x+1.5 y) sq ft

$2.5x + 1.5y < 3600$

900 collegiate and 1100 Mini are sold per week

$X<900$

$Y<1100$

Total labor required to produce x collegiate, and y mini backpacks

(45x+ 40y) minutes

Available labor 35*40*60=84000 minutes

$45x + 40y <8400$

Therefore

Maximize $Z =30x+22y$

$2.5x+1.5y<3800$

$X<900$

$Y<1100$

$45x+40y <8400$

$X,Y>0$

2. The Weigelt Corporation has three branch plants with excess production capacity. Fortunately, the corporation has a new product ready to begin production, and all three plants have this capability, so some of the excess capacity can be used in this way. This product can be made in three sizes--large, medium, and small--that yield a net unit profit of $420, $360, and $300, respectively. 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. The amount of available in-process storage space also imposes a limitation on the production rates of the new product. 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. 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. At each plant, some employees will need to be laid off unless most of the plant's excess production capacity can be used to produce the new product. 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. Management wishes to know how much of each of the sizes should be produced by each of the plants to maximize profit

Solution

a. Define the decision variables

L1 = number of large units produced per day at Plant 1,

M1 = number of medium units produced per day at Plant 1,

S1= number of small units produced per day at Plant 1,

L2 =number of large units produced per day at Plant 2, M2 = number of medium units produced per day at Plant 2,

S2 = number of small units produced per day at Plant 2,

L3 =number of large units produced per day at Plant 3,

M3 = number of medium units produced per day at Plant 3,

S3 = number of small units produced per day at Plant 3,

Maximize $420\,L1 + 360\,M1 + 300\,S1 + 420\,L2 + 360\,M2 + 300\,S2 + 420\,L3 + 360\,M3 + 300\,S3$

Subject to

(capacity).

$L1 + M1 + S1 < 750$

$L2 + M2 + S2 < 900$

$L3 + M3 + S3 < 450$

(Square footage)

$20L1 + 15M1 + 12\,S1 < 13000$

$20L2 + 15\,M2 + 12S2 < 12000$

$20\,L3 + 15\,M3 + 12\,S3 < 5000$

(sales)

$L1 + L2 + L3 < 900$

$M1 + M2 + M3. < 1200$

$S1 + S2 + S3. < 750$

(Same percentage of capacity)

$1/750\ (L1+M1 + S1) - 1/900(L2+M2 +S2) =0$

$1/750(L1+M1+ S1) - 1/450\ (L3+M3+S3) =0$

Non negativity

$L1 > 0,\ M1>0, S1>0, L2>0, M2>0, S2>0,$

$L3>0,\ M3> 0, S3> 0$

All ≥ 0