Fall 2022 QUANTITATIVE MANAGEMENT MODELING (MIS-64018-003)

Assignment: Module 2 - The LP Model

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Solution 1:

Writing all the important information from the problem:

Given

- Two different models - Collegiate and the Mini.
  Let us denote Collegiate Model = **X1** and Mini Model = **X2**

- Back savers have a long-term contract
  5000 sq. foot shipment of material each week.

- Each Collegiate requires 3 square feet = **3X1**
  Each Mini requires 2 square feet = **2X2**

  Therefore, the total nylon fabric required can be written as:
  3X1 + 2X2 ≤ 5000

- The sales forecasts indicate that at most 1000 collegiates can be sold per week
  X1 ≤ 1000
  Also, 1200 mini backpacks can be sold per week
  X2 ≤ 1200

- Each collegiate requires 45 minutes of labor to produce = **45X1**
  Each mini backpack requires 40 minutes of labor to produce = **40X2**

  Which can be written as :
  Total labor time required by collegiate and mini backpacks= **(45X1 + 40X2)**

- Back Savers has 35 laborers that each provide 40 hours of labor per week.

  Therefore total available labor time is = No of employees x hours per week x 60 mins

  35 x 40 x 60 = 84000 minutes

  Which can be written as :
  45X1 + 40X2 ≤ 84000

- Profit generated
  By collegiate = $ 32 per unit
  By mini backpack = $ 24 per unit

  We will denote profit by Z
  This can be written as : **Z = $(32X1 + 24X2)**

ANSWERS:

a. Clearly define the decision variables

Decision variables are :
Collegiate Model = X1
Mini Model = X2

b. What is the objective function?
(Maximise Profit) Z = $(32X1 + 24X2)

c. What are the constraints?
Constraints :

Subject to,
$3X1 + 2X2 \leq 5000$ (material usage)

$X1 \leq 1000$ (quantity sold)

$X2 \leq 1200$ (quantity sold)

$45X1 + 40X2 \leq 84000$ (labor time)

And $X1 , X2 \geq 0$ (non-negative)

Solution 2:

Writing all the important information from the problem:

- There are total of three plants : Plant 1, Plant 2, Plant 3
  Each plant produce large, medium and small size produce

  Therefore, let us denote Plant 1 by P1 and the sizes by l(Large), m(Medium), s(Small)

  The total number of variables are:
  For Plant 1 : P1l, P1m, P1s
  For Plant 2: P2l, P2m, P2s
  For Plant 3: P3l, P3m, P3s

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

- Plant 1 has the excess capacity to produce 750units per day of this product.
  $P1l + P1m + P1s \leq 750$

  Plant 2 has the excess capacity to produce 900 units per day of this product.
  $P2l + P2m + P2s \leq 900$

  Plant 3 has the excess capacity to produce 450 units per day of this product.
  $P3l + P3m + P3s \leq 450$

- Available storage for each plant

note: each unit of the large, medium, and small sizes produced per day requires 20, 15, and 12 square feet, respectively.

Plant 1 has 13000 sq. feet of in-process storage available for a day's production

$20P1l + 15P1m + 12P1s \leq 13000$

Plant 2 has 12000 sq. feet of in-process storage available for a day's production
$20P2l + 15P2m + 12P2s \leq 12000$

Plant 3 has 5000 sq. feet of in-process storage available for a day's production
$20P3l + 15P3m + 12P3s \leq 5000$

- 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.

Capacity utilisation of each plant :
$P1l + P2l + P3l \leq 900$ (Large)
$P1m + P2m + P3m \leq 1200$ (Medium)
$P1s + P2s + P3s \leq 750$ (Small)

$\frac{1}{750}(P1l + P1m + P1s) - \frac{1}{900}(P2l + P2m + P3s) = 0$

$\frac{1}{750}(P1l + P1m + P1s) - \frac{1}{450}(P2l + P2m + P3s) = 0$

ANSWERS:

a. Clearly define the decision variables

The total number of decision variables are "nine"
For Plant 1 : P1l, P1m, P1s
For Plant 2: P2l, P2m, P2s
For Plant 3: P3l, P3m, P3s

b. What is the objective function?
Maximise
$Z = (420P1l + 360P1m + 300P1s) + (420P2l + 360P2m + 300P2s) + (420P3l + 360P3m + 300P3s)$
Plant 1 Plant 2 Plant 3
Profit is denoted by Z

c. What are the constraints?
Constraints :

Subject to :
$P1l + P1m + P1s \leq 750$
$P2l + P2m + P2s \leq 900$
$P3l + P3m + P3s \leq 450$

$20P1l + 15P1m + 12P1s \leq 13000$
$20P2l + 15P2m + 12P2s \leq 12000$
$20P3l + 15P3m + 12P3s \leq 5000$

P1l + P2l + P3l ≤ 900 (Large)
P1m + P2m + P3m ≤ 1200 (Medium)
P1s + P2s + P3s ≤ 750 (Small)

$\frac{1}{750}$(P1l + P1m + P1s) - $\frac{1}{900}$ (P2l + P2m + P3s) = 0

$\frac{1}{750}$(P1l + P1m + P1s) - $\frac{1}{450}$ (P2l + P2m + P3s) = 0

Non-negativity: Z ≥ 0, P1l ≥0, P1m ≥0, P1s ≥0, P2l ≥0, P2m ≥0, P2s ≥0, P3l ≥0, P3m ≥0, P3s≥0