ASSIGNMENT 2

LINEAR PROGRAMMING

(A) Defining Variables: -

X1 = Number of Full-time consultants working during the shift morning (8 am – 4 pm)

X2 = Number of Full-time consultants working during the shift afternoon (noon – 8 pm)

X3 = Number of Full-time consultants working during the shift evening (4pm– midnight)

Y1 = Number of part time consultants working during the shift (8am– noon)

Y2 = Number of part time consultants working during the shift (noon– 4pm)

Y3= Number of part time consultants working during the shift (4pm– 8pm)

Y4 = Number of part time consultants working during the shift (8pm– midnight)

Objective Function: -

Minimizing cost Staffing Z = (14 x 8) (X1 + X2 + X3) + (12 x 4) (Y1 + Y2 + Y3 + Y4)

Subject to

X1 + Y1 ≥ 4 (8 am – 4 pm, Part time shit of Y1 is completed)

X1 + X2 + Y2 ≥ 8 (noon – 8 pm, full time shift of X1 is completed)

X2 + X3 + Y3 ≥10 (4pm– midnight, full time shift of X2 is completed)

X3 + Y4 ≥6 (8pm– midnight, full time shift of X3 is completed)

X1≥Y1

X1 + X2 ≥Y2  For every part-time consultant there should be a at least full time consultant is

X2 + X3 ≥Y3 required in each shift

X3≥Y4

And

Xi ,Yi  ≥ 0

Since our main objective is minimizing cost Staffing

As the part time work cost less than Full time workers, we can hire more part time workers

By the above equations we can say that Y4 = 3, Y3 = 5, Y2 =4 and Y1 =2

Where X3=2, X2=2, X1=3

Minimizing cost function Z= 112\*(3+2+2) +48\*(3+5++2) = 1456

(b) Since we are decided to give a meal break of 1 hour to Full time workers

One full time worker has a period of 8 hours and we are giving a break of 1 hour so they will get paid for 7 hours

Cost calculated for one full time worker after having break (14\*8) -(14) = 98

Then resultant objective function

Minimizing cost Staffing Z = 98 (X1 + X2 + X3 ) + 48 ( Y1 + Y2 + Y3 + Y4 )

Subject to

X1 + Y1 ≥ 4 (8 am – 4 pm, Part time shit of Y1 is completed)

X1 + X2 + Y2 ≥ 8 (noon – 8 pm, full time shift of X1 is completed)

X2 + X3 + Y3 ≥10 (4pm– midnight, full time shift of X2 is completed)

X3 + Y4 ≥6 (8pm– midnight, full time shift of X3 is completed)

X1≥Y1

X1 + X2 ≥Y2  For every part-time consultant there should be a at least full time consultant is

X2 + X3 ≥Y3 required in each shift

X3≥Y4

We know that

By the above equations we can say that Y4 = 3, Y3 = 5, Y2 =4 and Y1 =2

Where X3=2 , X2=2, X1=3

Minimizing cost function Z= 98\*(3+2+2) +48\*(3+5++2) = 1358

2) The decision variables identified in the problem is, **How much quantity of each type of Backpack’s** is to be produced in every week with respect to maximizing the profits of Back Savers.

For finding out quantity of each type of backpack we are defining the variables as below:

**X = Units of number Collegiate to be produced in each week**

**Y = Units of number Mini to be produced in each week**

The main objective for the Back Savers company is to maximize the profits by selling the Back packs. Since it is given that by selling a unit of collegiate, they are earning a profit of $32 per week and by selling a mini they are earning a profit off $ 24.

We can define our objective function as below:

**MAXMIZE Z = 32 X + 24 Y**

In the given problem there are two different types of constraints i.e. Material availability of nylon and time taken by the labor to manufacture Back packs

1. Material Availability of nylon sheet: -

Collegiate requires 3mt of nylon sheet and mini requires 2mt and there is limited availability of nylon sheet i,e 5000 meters. We can define the constraint as:-

**3X + 2 Y ≤ 5000**

b. Time taken by Labor to for production of Back Packs: -

Since it is mentioned that they are 35 labor and they are available for 40 hours a week. We can get the total time availability as 35\*40 = 1400 hours/week. Also, collegiate requires 45 mins and mins require 40 mins for one-unit production. We can define the constraint as: -

**45X + 40 Y ≤ 84000**

Proceeding as for the Back Savers, we can now formulate the mathematical

model for this general problem of allocating resources to activities. In particular,

this model is to select the values for X and Y so as to

**Maximize Z = 32 X + 24 Y**

Subject to the restrictions

**3 X + 2 Y ≤ 5000 (NYLON SHEET)**

**X ≤ 1000 (ATMOST SALES)**

**Y ≤ 1200 (ATMOST SALES)**

**45 X + 40 Y ≤ 84000 (TIME PERIOD)**

And

**X ≥ 0, Y ≥ 0**

**Graphical Method: -**

By taking the equation

3 X + 2 Y = 5000

Taking

X =0; Y = 2500

Y = 0; X = 1666.6

And the other equation

45 X + 40 Y ≤ 84000

Dividing the whole equation by “5”

9 X + 8 Y **≤** 16800

**Taking**

X =0; Y = 2100

Y = 0; X = 1866.6

Other Equation

X ≤ 1000

Y ≤ 1200

And the graphical representation is shown in excel file link.

[**2 nd problem lp assignment.xlsx**](2%20nd%20problem%20lp%20assignment.xlsx)

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**3)**

* 1. Define the decision variables
  2. Formulate a linear programming model for this problem.

c. Solve the problem using *lpsolve*, or any other equivalent library in R

Decision Variables: -

There are 9 decision variables in the model

Let

Xij = Total quantity of products produced per day

Where I = 1,2,3 represents plants respectively

j =L, M, S are the sizes of products where L=LARGE M=MEDIUM S=SMALL

X1L = Total quantity of Large size products produced per day by plant 1

X1M = Total quantity of Medium size products produced per day by plant 1

X1S = Total quantity of Small size products produced per day by plant 1

X2L = Total quantity of Large size products produced per day by plant 2

X2M = Total quantity of Medium size products produced per day by plant 2

X2S = Total quantity of small size products produced per day by plant 2

X3L = Total quantity of Large size products produced per day by plant 3

X3M = Total quantity of Medium size products produced per day by plant 3

X3S = Total quantity of small size products produced per day by plant 3

Here our main objective function is to maximize the net profit produced by each plant: -

**Maximize Z = 420 X1L + 360 X1M + 300 X1S + 420 X2L + 360 X2M + 300 X2S**

**+ 420 X3L + 360 X3M + 300 X3S**

Subject to

X1L + X1M + X1S  ≤ 750 Maximum Capacity for each plant

X2L + X2M + X2S  ≤ 900 to produce of all sizes

X3L + X3M + X3S  ≤ 450

20 X1L + 15 X1M + 12 X1S  ≤ 13000 Storage space of new product for

20 X2L + 15 X2M + 12 X2S  ≤ 12000 each plant

20 X3L + 15 X3M + 12 X3S  ≤ 5000

900\*(X1L + X1M + X1S) – 750\*(X2L + X2M + X2S) = 0 Same percentage of

450\*(X2L + X2M + X2S) – 900\*(X3L + X3M + X3S) = 0 Capacity

450\*(X1L + X1M + X1S) – 750\*(X3L + X3M + X3S) = 0

X1L + X2L + X3L  ≤ 900

X1M + X2M + X3M  ≤ 1200 Maximum sale forecast of all sizes

X1S + X2S + X3S  ≤ 750

And

Xij ≥ 0