Assignment 2_QMM_lpsolve

Nanaji

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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 combinat.ion 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.

Answer to the question

Suppose,

Let Plant 1 be

$$= A$$

Let Plant 2 be

$$= B$$

Let Plant 3 be

$$= C$$

Let the production of Plant 1 in Large be

$$A_l$$

Let the production of Plant 1 in Medium be

$$A_m$$

Let the production of Plant 1 in Small be

$$A_s$$

Let the production of Plant 2 in Large be

$$B_l$$

Let the production of Plant 2 in Medium be

$$B_m$$

Let the production of Plant 2 in Small be

$$B_s$$

Let the production of Plant 3 in Large be

$$C_l$$

Let the production of Plant 3 in Medium be

$$C_m$$

Let the production of Plant 3 in Small be

$$C_s$$

The objective function is:

$$Max \quad Z = 420(A_l + A_s) + 360(B_l + B_m + B_s) + 300(C_m + C_s)$$

Improvising the objective function:

$$Max \quad Z = 420A_l + 420A_m + 420A_s + 360B_l + 360B_m + 360B_s + 300C_l + 300C_m + 300C_s$$

Subject to the following:

$$A_l + A_m + A_s \leq 750$$
$$B_l + B_m + B_s \leq 900$$
$$C_l + C_m + C_s \leq 450$$
$$20A_l + 15A_m + 12A_s \leq 13000$$
$$20B_l + 15B_m + 12B_s \leq 12000$$
$$20C_l + 15C_m + 12C_s \leq 5000$$
$$A_l + B_l + C_l \leq 900$$
$$A_m + B_m + C_m \leq 1200$$
$$A_s + B_s + C_s \leq 750$$

Non-negativity constraints:

$$A_l + B_l + C_l + A_m + B_m + C_m + A_s + B_s + C_s \geq 0$$

These constraints can be written in another format

$$A_l + A_m + A_s + 0B_l + 0B_m + 0B_s + 0C_l + 0C_m + 0C_s \leq 750$$
$$0A_l + 0A_m + 0A_s + B_l + B_m + B_s + 0C_l + 0C_m + 0C_s \leq 900$$
$$0A_l + 0A_m + 0A_s + 0B_l + 0B_m + 0B_s + C_l + C_m + C_s \leq 450$$
$$20A_l + 15A_m + 12A_s + 0B_l + 0B_m + 0B_s + 0C_l + 0C_m + 0C_s \leq 13000$$
$$0A_l + 0A_m + 0A_s + 20B_l + 15B_m + 12B_s + 0C_l + 0C_m + 0C_s \leq 12000$$
$$0A_l + 0A_m + 0A_s + 0B_l + 0B_m + 0B_s + 20C_l + 15C_m + 12C_s \leq 5000$$
$$A_l + 0A_m + 0A_s + B_l + 0B_m + 0B_s + C_l + 0C_m + 0C_s \leq 900$$
$$0A_l + A_m + 0A_s + 0B_l + 0B_m + 0B_s + 0C_l + C_m + 0C_s \leq 1200$$
$$0A_l + 0A_m + A_s + 0B_l + 0B_m + B_s + 0C_l + 0C_m + C_s \leq 750$$

```r
#Solution

#installing the required packages
#install.packages("lpSolve")

#library
library(lpSolve)


#The objective function is to maximize A = 420A_l + 360A_m + 300A_s + 420B_l + 360B_m + 300B_s + 420C_l

obj_fun<-c(420,360,300,420,360,300,420,360,300)

#Below constraints written in the matrix form:

con_fun <-matrix(c(1,1,1,0,0,0,0,0,0,
                   0,0,0,1,1,1,0,0,0,
                   0,0,0,0,0,0,1,1,1,
                   20,15,12,0,0,0,0,0,0,
                   0,0,0,20,15,12,0,0,0,
                   0,0,0,0,0,0,20,15,12,
                   1,0,0,1,0,0,1,0,0,
                   0,1,0,0,1,0,0,1,0,
                   0,0,1,0,0,1,0,0,1), nrow = 9, byrow = TRUE)
```

```r
#set the direction of the inequalities using subject to equation

dir_fun<-c("<=",
           "<=",
           "<=",
           "<=",
           "<=",
           "<=",
           "<=",
           "<=",
           "<=")
```

```r
#set the right hand side of the coefficients

rhs_fun <-c(750,
            900,
            450,
            13000,
            12000,
            5000,
            900,
            1200,
            750)
```

```r
#finding the objective function value


lp("max", obj_fun, con_fun, dir_fun, rhs_fun)
```

```
## Success: the objective function is 708000
```