LP model

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Below are the decision varibles which are denoted as follows:

Function

$$= X_{ij}$$

where,
size (L,M,S)

$$=_i$$

plant (1,2,3)

$$=_j$$

number_of_large_units_produced_at_plant_1

$$= X_{L1}$$

number_of_medium_units_produced_at_plant_1

$$= X_{M1}$$

number_of_small_units_produced_at_plant_1

$$= X_{S1}$$

number_of_large_units_produced_at_plant_2

$$= X_{L2}$$

number_of_medium_units_produced_at_plant_2

$$= X_{M2}$$

number_of_small_units_produced_at_plant_2

$$= X_{S2}$$

number_of_large_units_produced_at_plant_3

$$= X_{L3}$$

number_of_medium_units_produced_at_plant_3

$$= X_{M3}$$

number_of_small_units_produced_at_plant_3

$$= X_{S3}$$

Decision_Variables:

$$X_{L1}, X_{M1}, X_{S1}$$

$$X_{L2}, X_{M2}, X_{S2}$$

$$X_{L3}, X_{M3}, X_{S3}$$

Objective_Function is:

$$Max \;\; Z = 420(X_{L1} + X_{L2} + X_{L3}) + 360(X_{M1} + X_{M2} + X_{M3}) + 300(X_{S1} + X_{S2} + X_{S3})$$

Subject_to_the_constraints:
Capacity_Constraint:

$$X_{L1} + X_{M1} + X_{S1} \leq 750$$

$$X_{L2} + X_{M2} + X_{S2} \leq 900$$

$$X_{L3} + X_{M3} + X_{S3} \leq 450$$

Storage_Constraint:

$$20X_{L1} + 15X_{M1} + 12X_{S1} \leq 13000$$

$$20X_{L2} + 15X_{M2} + 12X_{S2} \leq 12000$$

$$20X_{L3} + 15X_{M3} + 12X_{S3} \leq 5000$$

Sales_Constraint:

$$X_{L1} + X_{L2} + X_{L3} \leq 900$$

$$X_{M1} + X_{M2} + X_{M3} \leq 1200$$

$$X_{S1} + X_{S2} + X_{S3} \leq 750$$

Equal_percentage_of_capacity_utilization:

$$1/750(X_{L1} + X_{M1} + X_{S1}) = 1/900(X_{L2} + X_{M2} + X_{S2})$$

$$1/750(X_{L1} + X_{M1} + X_{S1}) = 1/450(X_{L3} + X_{M3} + X_{S3})$$

Non_negativity_of_the_decision_variables:

$$X_{L1} \geq 0, X_{M1} \geq 0, X_{S1} \geq 0, X_{L2} \geq 0, X_{M2} \geq 0, X_{S2} \geq 0, X_{L3} \geq 0, X_{M3} \geq 0, X_{S3} \geq 0$$

Solving using R:

```
library(lpSolve)
```

```
## Warning: package 'lpSolve' was built under R version 4.3.3
```

```
#Objective_function
func_objective = c(420,360,300,420,360,300,420,360,300)


#Constraints
Fun_constraint = 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,
                          1/750,1/750,1/750,-1/900,-1/900,-1/900,0,0,0,
                          1/750,1/750,1/750,0,0,0,-1/450,-1/450,-1/450,
                          0,0,0,1/900,1/900,1/900,-1/450,-1/450,-1/450),nrow = 12,byrow = TRUE)




#Direction
fun_direction = c("<=","<=",
                  "<=","<=",
                  "<=","<=",
                  "<=","<=",
                  "<=","<=",
                  "<=","<=")

#RHS
fun_RHS = c(750,900,450,13000,12000,5000,900,1200,750,0,0,0)
```

```r
# Z Value
maxmized_profit=lp("max",func_objective,Fun_constraint,fun_direction,fun_RHS)
maxmized_profit$objval
```

```
## [1] 696000
```

```r
#Final value of the decision variables
maxmized_profit$solution
```

```
## [1] 516.6667 177.7778   0.0000   0.0000 666.6667 166.6667   0.0000   0.0000
## [9] 416.6667
```