Assignment 2

Noorah

10/3/2021

3.(Weigelt Production)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.

a.Define the decision variables

Defining the decision variables to maximize the company profit by producing more products.

X = Number of units produced in the plant

X1= Plant 1 X2= Plant 2 X3= Plant 3

L = Large size product M= Medium size product S= Small size product

XL= Number of large size products produced in X1, X2 and X3 XM= Number of medium size products produced in X1, X2 and X3 XS= Number of small size products produced in X1, X2 and X3

b. Formulate a linear programming model for this problem.

Formula to maximize the profit:

Z= 420[(X1L) + (X2L) + (X3*L)] + 360[(X1M) + (X2M) + (X3*M)] +300[(X1S) + (X2S) + (X3*S)]

Total number of products produced by size:

L= (X1L) + (X2L) + (X3L) M=(X1M) + (X2M) + (X3M) S= (X1S) + (X2S) + (X3*S)

Plant products production by day:

Plant 1 = [(X1L) + (X1M) + (X1*S)] ≤ 750 Plant 2 = [(X2L) + (X2M) + (X2*S)] ≤ 900 Plant 3 = [(X3L) + (X3M) + (X3*S)] ≤ 450

Plant storage for products by day:

Plant 1 = [(20X1L) + (15X1M) + (12X1*S)] ≤ 13000 Plant 2 = [(20X2L) + (15X2M) + (12X2*S)] ≤ 12000 Plant 3 = [(20X3L) + (15X3M) + (12X3*S)] ≤ 5000

Sales for products by day:

L= [(X1L) + (X2L) + (X3*L)] ≤ 900 M=[(X1M) + (X2M) + (X3*M)] ≤ 1200 S= [(X1S) + (X2S) + (X3*S)] ≤ 750

All plants should have the same percentage capacity to produce new products:

a. 900 [(X1L) + (X1M) + (X1*S)] – 750 [(X2L) + (X2M) + (X2*S)]=0
b. 450 [(X2L) + (X2M) + (X2*S)] – 900 [(X3L) + (X3M) + (X3*S)]=0
c. 450 [(X1L) + (X1M) + (X1*S)] – 750 [(X3L) + (X3M) + (X3*S)]=0

in conclusion, all values must be greater or equal to 0 L,M and S ≥ 0 XL, XM, and XS ≥ 0

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

```r
###installing package
library(lpSolveAPI)
```

```r
### creating lp with o constraints and 9 decision variables
lprec <-make.lp(0,9)
lprec
```

```
## Model name:
##   a linear program with 9 decision variables and 0 constraints
```

```r
### Using Max function to maximize the profit
set.objfn(lprec, c(420,360,300,420,360,300,420,360,300))
lp.control(lprec,sense="max")
```

```
## $anti.degen
## [1] "none"
##
## $basis.crash
## [1] "none"
##
## $bb.depthlimit
## [1] -50
##
## $bb.floorfirst
## [1] "automatic"
##
## $bb.rule
## [1] "pseudononint" "greedy"       "dynamic"      "rcostfixing"
##
## $break.at.first
## [1] FALSE
##
## $break.at.value
## [1] 1e+30
##
## $epsilon
##       epsb       epsd      epsel     epsint epsperturb   epspivot
##      1e-10      1e-09      1e-12      1e-07      1e-05      2e-07
##
## $improve
## [1] "dualfeas" "thetagap"
##
## $infinite
## [1] 1e+30
##
## $maxpivot
## [1] 250
##
## $mip.gap
## absolute relative
##    1e-11    1e-11
##
## $negrange
## [1] -1e+06
##
## $obj.in.basis
## [1] TRUE
##
## $pivoting
## [1] "devex"    "adaptive"
##
## $presolve
## [1] "none"
##
## $scalelimit
## [1] 5
##
## $scaling
## [1] "geometric"   "equilibrate" "integers"
##
## $sense
## [1] "maximize"
##
## $simplextype
## [1] "dual"   "primal"
##
## $timeout
## [1] 0
##
## $verbose
## [1] "neutral"
```

```r
###Plant products production by day
add.constraint(lprec,c(1, 1, 1, 0, 0, 0, 0, 0, 0), "<=",750)
add.constraint(lprec,c(0, 0, 0, 1, 1, 1, 0, 0, 0), "<=",900)
add.constraint(lprec,c(0, 0, 0, 0, 0, 0, 1, 1, 1), "<=",450)

###Plant storage for products by day
add.constraint(lprec,c(20, 15, 12, 0, 0, 0, 0, 0, 0), "<=",13000)
add.constraint(lprec,c(0, 0, 0, 20, 15, 12, 0, 0, 0), "<=",12000)
add.constraint(lprec,c(0, 0, 0, 0, 0, 0, 20, 15, 12), "<=",5000)

###Sales for products by day:
add.constraint(lprec,c(1, 1, 1, 0, 0, 0, 0, 0, 0), "<=",900)
add.constraint(lprec,c(0, 0, 0, 1, 1, 1, 0, 0, 0), "<=",1200)
add.constraint(lprec,c(0, 0, 0, 0, 0, 0, 1, 1, 1), "<=",750)

###All plants should have the same percentage capacity to produce new products
add.constraint(lprec, c(6, 6, 6, -5, -5, -5, 0, 0, 0), "=",0)
add.constraint(lprec, c(3, 3, 3, 0, 0, 0, -5, -5, -5), "=",0)

RN <- c("CCon1", "CCon2", "CCon3", "SCon1", "SCon2", "SCon3", "SaCon1", "SaCon2", "SaCon3", "%C1", "%C2")
CN <- c("P1L", "P1M", "P1S", "P2L", "P2M", "P2S", "P3L", "P3M", "P3S")
dimnames(lprec) <- list(RN, CN)
lprec
```

```
## Model name:
##   a linear program with 9 decision variables and 11 constraints
```

```r
write.lp(lprec, filename = "Assign2Q3", type = "lp")
```

```r
### Final answer
solve(lprec)
```

```
## [1] 0
```

```r
get.objective(lprec)
```

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

```r
get.variables(lprec)
```

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

Answer is :

z= 696000$