|  |  |
| --- | --- |
| Time period | Number of consultants |
| 8AM – 12PM | 4 |
| 12PM-4PM | 8 |
| 4PM-8PM | 10 |
| 8PM-12AM | 6 |

Question 1

a) Determine a minimum-cost staffing plan for the center. In your solution, how many consultants will be paid to work full time and how many will be paid to work part time? What is the minimum cost?

Fi = Number of full time computer consultants in 3 shifts. i = 1,2,3(Each shift is of 8 hours)

Pj = Number of part time computer consultants in 4 shifts. j = 1,2,3,4 (Each shift is of 4 hours)

Pay for full time consultants = $14/hr

Pay for part time consultants = $12/hr

Zmin = Minimum Cost

Zmin = (F1 + F2 + F3) \* 14 \* 8 + (P1 + P2 + P3 + P4) \* 12 \* 4

ST

F1 + P1 ≥ 4

F1 + F2 + P2 ≥ 8

F2+ F3 + P3 ≥ 10

F3 + P4 ≥ 6

F1 ≥ P1

F1 + F2 ≥ P2

F2 + F3 ≥ P3

F3 ≥ P4

Fi ≥ Pj ≥ 0

P1 = 2, P2 = 4, P3 = 5, P4 = 3

and

F1 = 2, F2 = 2, F3 = 3

Zmin = (2 + 2 + 3) \* 14 \* 8 + (2 + 4 + 5 + 3) \* 12 \* 4

= 784 + 672

= 1456

Total Full-time workers = 7

Total Part time workers = 14

b) After thinking about this problem for a while, you have decided to recognize meal breaks explicitly in the scheduling of full-time consultants. In particular, full-time consultants are entitled to a one-hour lunch break during their eight-hour shift. In addition, employment rules specify that the lunch break can start after three hours of work or after four hours of work, but those are the only alternatives. Part-time consultants do not receive a meal break. Under these conditions, find a minimum-cost staffing plan. What is the minimum cost?

1 hour break to full time workers and no break to part time workers. Considering this, we need to subtract the pay/hour from the Zmin function.

Constraints will remain the same. The new cost function is as below:

Zmin1 = (F1 + F2 + F3) \* 14 \* 8 + (P1 + P2 + P3 + P4) – (F1 + F2 + F3) \* 14

= 7\*112 + 14\*48 – 7\*14

= 1358

Zmin - Zmin1 = 1456 – 1358 = 98

Question 2

Back Savers is a company that produces backpacks primarily for students. They are considering offering some combination of two different models—the Collegiate and the Mini. Both are made out of the same rip-resistant nylon fabric. Back Savers has a long-term contract with a supplier of the nylon and receives a 5000 square-foot shipment of the material each week. Each Collegiate requires 3 square feet while each Mini requires 2 square feet. The sales forecasts indicate that at most 1000 Collegiates and 1200 Minis can be sold per week. Each Collegiate requires 45 minutes of labor to produce and generates a unit profit of $32. Each Mini requires 40 minutes of labor and generates a unit profit of $24. Back Savers has 35 laborers that each provides 40 hours of labor per week. Management wishes to know what quantity of each type of backpack to produce per week. Solve this problem graphically.

Diagram

Description automatically generated

Question 3

a.Define the decision variables

Wxy , here x denotes plants 1,2,3 whereas y is the sizes l, m, s.

W1l, W1m, W1s – variables of plant 1

W2l, W2m, W2s – variables of plant 2

W3l, W3m, W3s – variables of plant 3

b.Formulate a linear programming model for this problem.

Zmax = (W1l + W2l + W3l) \* 420 + (W1m + W2m + W3m) \* 360 + (W1s + W2s + W3s) \* 300

Subject to:

W1l + W1m + W1s ≤ 750

W2l + W2m + W2s ≤ 900

W3l + W3m + W3s ≤ 450

20\*W1l + 15\*W1m + 12\*W1s ≤ 13000

20\*W2l + 15\*W2m + 12\*W2s ≤ 12000

20\*W3l + 15\*W3m + 12\*W3s ≤ 5000

900\*(W1l + W1m + W1s) – 750\*(W2l + W2m + W2s) = 0

450\*(W2l + W2m + W2s) – 900\*(W3l + W3m + W3s) = 0

450\*(W1l + W1m + W1s) – 750\*(W3l + W3m + W3s) = 0

W1l+W2l+W3l<=900

W1m+W2m+W3m<=1200

W1s+W2s+W3s<=750

Wxy ≥ 0 here x = 1, 2, 3 and y = l, m, s

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

library(lpSolveAPI)

w <- make.lp(0,3,verbose = "neutral")

w

add.constraint(w, c(1,1,1), "<=", 750 )

add.constraint(w, c(1,1,1), "<=", 900)

add.constraint(w, c(1,1,1), "<=", 450)

add.constraint(w, c(20,15,12), "<=", 13000)

add.constraint(w, c(20,15,12), "<=", 12000)

add.constraint(w, c(20,15,12), "<=", 5000)

add.constraint(w, c(1,1,1), "<=", 900)

add.constraint(w, c(1,1,1), "<=", 1200)

add.constraint(w, c(1,1,1), "<=", 750)

w.col <- c("Plant 1","Plant 2","Plant 3")

w.row <- c("W1l","W1m","W1s","W2l", "W2m","W2s","W3l","W3m","W3s")

dimnames(w) <- list(w.row,w.col)

w

solve(w)

Text

Description automatically generated