Linear Programming Problem 2

Question 2

A commercial building has a total floor area of 960m². The fit-out is a combination of offices and shops. Typically, each shop has a floor area of 60m² and each office 20m². Naturally being larger, each shop takes 5 days to complete compared to each office taking just 3 days. The maximum time allowed to complete the project is 120 days. However, the local council has stipulated that 10 shops must be constructed.

1. Working within these constraints, maximise the rental income for the developer if each shop generates €200 pw and each office €100 pw.
2. Without the request for10 shops, what is the new optimal office/ shop combination?

Answer:

Constraints: *Area, Time, Council requirements*

Variables: shops = x

Offices = y

*Area*

60x +20y ≤960

Find coordinates of the linear equation

60(0) + 20y =960

960÷20 = 48

y = 48

(0,48)

60x + 20(0) =960

960÷60 = 16

x = 16

(16,0)

*Time*

5x + 3y ≤120

Find coordinates of the linear equation

5(0) + 3y =120

120÷3 = 40

y = 40

(0,40)

5x + 3(0) = 120

120÷ 5 = 24

x = 24

(24,0)

*Council requirement*

x ≤ 10

x≥ 0

y≥ 0

Variable function: (outcome) Maximise rental

200x + 100y =

Plot constraints:





Substitute *origin* coordinates (0,0) into each linear plot to determine the feasible area.

60(0) +20(0) ≤960 True (towards origin)

5(0) + 3(0) ≤120 True (towards origin)

(0) ≤ 10 True (towards origin)



Points A, B, C, and D are points of intersection and possible optimal solutions

Point A

= (0,40)

Point B:

*Area* 60x +20y ≤960 intersects with

*Time* 5x + 3y ≤120

Solve as a simultaneous equation

= ( 6,30)

Point C:

*Area* 60x +20y ≤960 intersects with

Shops i.e. x = 10

So

60(10) +20y = 960

20y = 960 - 60(10)

20y =360

360÷20 = y = 18

= (10,18)

Point D:

= (10,0)

Variable Function: (outcome) Maximise rental

200x + 100y =

Point A

(0,40)

200(0) + 100(40) = €4000

Point B

(6,30)

200(6) + 100(30) = €4200

Point C

(10,18)

200(10) + 100(18) = €3800

Point D

200(10) + 100(0) = €2000

Conclusion

Point C meets the criteria for 10 shops with 18 offices. However, if the 10 shop restriction was lifted then point C would not be present and the true optimal return would be point B with a return of €4200.

Note:

* There is one point of intersection we haven’t accommodated??