

Situational Problem – The Band Manager (3 hours)

You are the manager of a music band, The Musical Spheres. You have been asked to evaluate different costs associated with a tour of regional arenas where the band will play in the next few weeks. You need to make sure that the band will generate a profit of at least \$50 000 with these concerts. No taxes need to be included.

Arenas, security, transportation and set-up

The band will play 9 shows in 9 different arenas. The cost for renting the arenas and to pay for the employees is the same at each venue and is set at \$4 500. Transportation and set-up costs for each show are estimated at \$1 500.

The Stage

You must decide which one of 3 types of rubber flooring will be used to cover the stage, so that the musicians are playing on an insulated and slip-free surface. A plan of the stage that will be used is shown below (all measures are in meters). The stage is made up of a rectangle, and 2 identical right triangles that face the audience.

The length of the rectangular section is equal to 4 times its width. The height of the 2 triangles is identical to the width of the rectangle. By adding the 2 triangles, the band increases the area where they can play and move around by 50 m², when compared to the area of the rectangle alone.

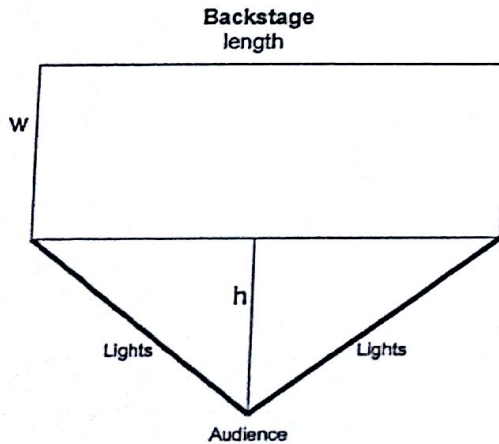


Table 1

Rubber flooring options	
Options	Cost (\$/m ²)
A (5 mm)	18.00
B (6 mm)	27.00
C (8 mm)	33.50

Table 1 shows the 3 types of flooring that are being considered. The entire stage will be covered (the rectangle and the 2 triangles), and an extra 5% of material will be purchased in case of mistakes during the installation or for repairs during the tour. They would like to buy the best quality of flooring available, and not necessarily the cheapest, but are not willing to spend more than \$5 000 for the rubber flooring.

You also need to calculate the cost of installing lights along the edges of the stage facing the audience (darker lines in the diagram above). The lights being considered are sold at \$58.95 per meter.

Printing of tickets

You need to make a choice between 2 printing companies to produce the tickets for the different shows of this tour. A total of 2 100 tickets need to be printed for each of the 9 shows.

Company 1 charges a base fee of \$1000, and then charges \$0.09 per ticket printed. The fee structure for Company 2 appears in table 2.

Table 2

Company 2 printing prices	
Number of tickets printed	Price (\$)
1000	1550
2000	1600
3000	1650
4000	1700
5000	1750

Because shows might be added or cancelled later, you need to determine under which conditions one company should be chosen over the other one in case more or fewer tickets need to be printed. You also need to determine which company the band should choose to print the tickets for the 9 shows already scheduled.

Electrical wiring

Electrical wiring of 2 different types will be needed for all the equipment. The wiring comes in rolls, and only complete rolls can be bought. The information related to the wiring appears in table 3 below.

NOTE: You need to purchase both the D and E types of wiring and not make a choice between the two.

Table 3

Electrical wiring information			
Type of wiring	Length of 1 roll (m)	Cost per roll (\$)	Length needed (m)
D	3×10^2	250	1 100
E	5×10^2	300	900

Ticket prices

Spectators will have a choice between 2 sections at the shows, the stands or the floor of the arena. 1 500 tickets will be available for spectators in the stands, and 600 for spectators on the floor.

You need to decide which of the 3 options you will use, in order to meet your financial goal of a profit for the tour of at least \$50 000. You need to keep in mind that you do not want your tickets to be too expensive and run the risk of not selling out each show, so you want to keep the ticket prices at a minimum, but still meet your goal.

- Option 1: Tickets in the stands at \$5 and tickets on the arena floor at \$10
- Option 2: Tickets in the stands at \$4 and tickets on the arena floor at \$8
- Option 3: Tickets in the stands at \$3 and tickets on the arena floor at \$6

Your Solution:

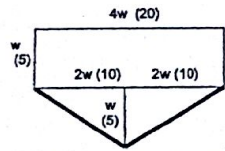
Arenas, security, transportation and set-up

For each show: rental + transportation = \$4 500 + \$1 500 = \$6 000

For all 9 shows: $9 \times \$6\,000 = \$54\,000$

A total expense of \$54 000.

The Stage



Area of rectangle = length x width = $4w \times w = 4w^2$
Area of 1 triangle = base x height / 2 = $2w \times w / 2 = w^2$
Area of 2 triangles = $2 \times w^2 = 2w^2$

Area of rectangle - Area of triangles = 50
 $4w^2 - 2w^2 = 50$
 $2w^2 = 50$
 $w^2 = 25$
 $w = 5\text{ m}$

$\frac{b}{2} = \frac{(4w)(w)}{2} = 50$
 $2w^2 = 50$
 $w^2 = 25$
 $w = 5$

Total stage area = Area of rectangle + area of triangles
 $= 4w^2 + 2w^2 = 6w^2$
 $= 6(5)^2 = 150\text{ m}^2$

Add 5% extra = $150 \times 1.05 = 157.50\text{ m}^2$

Option A = $157.50\text{ m}^2 \times \$18.00/\text{m}^2 = \$2835$
Option B = $157.50\text{ m}^2 \times \$27.00/\text{m}^2 = \$4252.50$ **Option B should be chosen**
Option C = $157.50\text{ m}^2 \times \$33.50/\text{m}^2 = \$5278.25$

Lights
 $c^2 = a^2 + b^2$
 $c^2 = 5^2 + 10^2$
 $c^2 = 25 + 100$
 $c^2 = 125$
 $\sqrt{c^2} = \sqrt{125} = 11.18\text{ m}$

Length needed = $2 \times 11.18 = 22.36\text{ m}$

Lights costs = $22.36\text{ m} \times \$58.95/\text{m} = \1318.12
\$1355.85

Your Solution:

Printing of tickets

Number of tickets needed = 9 shows x 2 100 tickets per show = 18 900 tickets

Company 1: $y_1 = 0.09x + 1\,000$
 $y_1 = 0.09x + 1\,000 = 0.09(18\,900) + 1\,000$
 $= \$2\,701$

Company 2: rate of change = $\frac{y_2 - y_1}{x_2 - x_1} = \frac{1\,600 - 1\,550}{2\,000 - 1\,000} = \frac{50}{1\,000} = 0.05$
Initial value = $b = y - ax$
 $= 1\,550 - 0.05(1\,000)$
 $= 1\,500$

$y_2 = 0.05x + 1\,500$
 $y_2 = 0.05x + 1\,500 = 0.05(18\,900) + 1\,500$
 $= \$2\,445$

Company 2 should be chosen and it will cost \$2 445.

Solving the system:

$$\begin{aligned} y_1 &= y_2 \\ 0.09x + 1\,000 &= 0.05x + 1\,500 \\ -0.05x & \quad -0.05x \\ 0.04x + 1\,000 &= 1\,500 \\ -1\,000 & \quad -1\,000 \\ 0.04x &= 500 \\ 0.04 & \quad 0.04 \\ x &= 12\,500 \end{aligned}$$

$$\begin{aligned} y_1 &= 0.09x + 1\,000 = 0.09(12\,500) + 1\,000 \\ x_1 &= 2\,125 \\ y_2 &= 0.05x + 1\,500 = 0.05(12\,500) + 1\,500 \\ x_2 &= 2\,125 \end{aligned}$$

System's solution = (12 500, 2 125)

Company 1 is a better choice for fewer than 12 500 tickets, and company 2 is a better choice for more than 12 500 tickets.

Electrical wiring

Wiring D:
 $1\,100 + (3 \times 10^3) = 3.7$ so 4 rolls needed
Cost = $4 \times \$250 = \$1\,000$

Wiring E:
 $900 + (5 \times 10^3) = 1.8$ so 2 rolls needed
Cost = $2 \times \$300 = \600

Total cost for the wiring = $1\,000 + 600 = \$1\,600$

Total Expenses

Total expenses = rentals + stage + lights + printing + wiring
 $= 54\,000 + 4\,252.50 + 1\,318.12 + 2\,445 + 1\,600$
 $= \$63\,615.62$
 $+ 50\,000$

Revenue 113 615.62

Your Solution:

Ticket prices

Option 1: $5(1\,500) + 10(600) = 13\,500$
Option 2: $4(1\,500) + 8(600) = 10\,800$
Option 3: $3(1\,500) + 6(600) = 8\,100$

For 9 shows = $9 \times 13\,500 = \$121\,500$
For 9 shows = $9 \times 10\,800 = \$97\,200$
For 9 shows = $9 \times 8\,100 = \$72\,900$

For a profit of at least \$50 000:

Ticket prices $\geq 50\,000 + \text{Total Expenses}$
Ticket prices $\geq 50\,000 + 63\,615.62$
Ticket prices $\geq \$113\,615.62$

So you need to choose Option 1.

CONCLUSION:
