

# Chapter 1

## Introduction

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### Learning Objectives

1. Develop a general understanding of the management science/operations research approach to decision making.
2. Realize that quantitative applications begin with a problem situation.
3. Obtain a brief introduction to quantitative techniques and their frequency of use in practice.
4. Understand that managerial problem situations have both quantitative and qualitative considerations that are important in the decision making process.
5. Learn about models in terms of what they are and why they are useful (the emphasis is on mathematical models).
6. Identify the step-by-step procedure that is used in most quantitative approaches to decision making.
7. Learn about basic models of cost, revenue, and profit and be able to compute the break-even point.
8. Obtain an introduction to microcomputer software packages and their role in quantitative approaches to decision making.
9. Understand the following terms:

model  
objective function  
constraint  
deterministic model  
stochastic model  
feasible solution

infeasible solution  
management science  
operations research  
fixed cost  
variable cost  
break-even point

### Solutions:

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1. Management science and operations research, terms used almost interchangeably, are broad disciplines that employ scientific methodology in managerial decision making or problem solving. Drawing upon a variety of disciplines (behavioral, mathematical, etc.), management science and operations research combine quantitative and qualitative considerations in order to establish policies and decisions that are in the best interest of the organization.
2. Define the problem  
 Identify the alternatives  
 Determine the criteria  
 Evaluate the alternatives  
 Choose an alternative  
 For further discussion see section 1.3
3. See section 1.2.
4. A quantitative approach should be considered because the problem is large, complex, important, new and repetitive.
5. Models usually have time, cost, and risk advantages over experimenting with actual situations.
6. Model (a) may be quicker to formulate, easier to solve, and/or more easily understood.
7. Let  $d =$  distance  
 $m =$  miles per gallon  
 $c =$  cost per gallon,

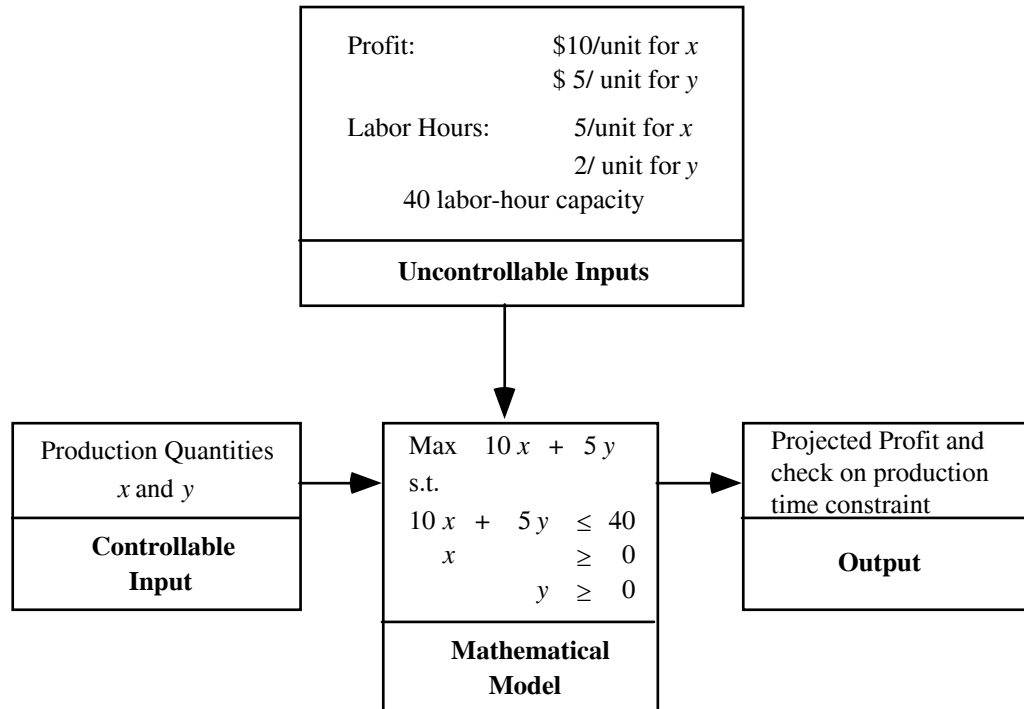
$$\therefore \text{Total Cost} = \left( \frac{2d}{m} \right) c$$

We must be willing to treat  $m$  and  $c$  as known and not subject to variation.

8. a. Maximize  $10x + 5y$   
 s.t.
 
$$5x + 2y \leq 40$$

$$x \geq 0, y \geq 0$$
- b. Controllable inputs:  $x$  and  $y$   
 Uncontrollable inputs: profit (10,5), labor hours (5,2) and labor-hour availability (40)

c.



- d.  $x = 0, y = 20$  Profit = \$100  
(Solution by trial-and-error)
- e. Deterministic - all uncontrollable inputs are fixed and known.
9. If  $a = 3, x = 13 \frac{1}{3}$  and profit = 133  
If  $a = 4, x = 10$  and profit = 100  
If  $a = 5, x = 8$  and profit = 80  
If  $a = 6, x = 6 \frac{2}{3}$  and profit = 67

Since  $a$  is unknown, the actual values of  $x$  and profit are not known with certainty.

10. a. Total Units Received =  $x + y$
- b. Total Cost =  $0.20x + 0.25y$
- c.  $x + y = 5000$
- d.  $x \leq 4000$  Kansas City Constraint  
 $y \leq 3000$  Minneapolis Constraint
- e. Min  $0.20x + 0.25y$   
s.t.
- $$\begin{array}{rcl} x + & y & = 5000 \\ x & & \leq 4000 \\ & y & \leq 3000 \end{array}$$
- $x, y \geq 0$

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11. a. at \$20  $d = 800 - 10(20) = 600$   
 at \$70  $d = 800 - 10(70) = 100$
- b.  $TR = dp = (800 - 10p)p = 800p - 10p^2$
- c. at \$30  $TR = 800(30) - 10(30)^2 = 15,000$   
 at \$40  $TR = 800(40) - 10(40)^2 = 16,000$   
 at \$50  $TR = 800(50) - 10(50)^2 = 15,000$   
 Total Revenue is maximized at the \$40 price.
- d.  $d = 800 - 10(40) = 400$  units  
 $TR = \$16,000$

12. a.  $TC = 1000 + 30x$
- b.  $P = 40x - (1000 + 30x) = 10x - 1000$
- c. Breakeven when  $P = 0$   
 Thus  $10x - 1000 = 0$   
 $10x = 1000$   
 $x = 100$

13. a. Total cost =  $4800 + 60x$
- b. Total profit = total revenue - total cost  
 $= 300x - (4800 + 60x)$   
 $= 240x - 4800$
- c. Total profit =  $240(30) - 4800 = 2400$
- d.  $240x - 4800 = 0$   
 $x = 4800/240 = 20$

The breakeven point is approximately 20 students.

14. a. Profit = Revenue - Cost  
 $= 20x - (80,000 + 3x)$   
 $= 17x - 80,000$

Break-even point

$$17x - 80,000 = 0$$

$$17x = 80,000$$

$$x = 4706$$

- b. Loss with Profit =  $17(4000) - 80,000 = -12,000$
- c. Profit =  $px - (80,000 + 3x)$   
 $= 4000p - (80,000 + 3(4000)) = 0$   
 $4000p = 92,000$   
 $p = 23$

d. Profit =  $\$25.95 (4000) - (80,000 + 3 (4000))$   
 =  $\$11,800$

Probably go ahead with the project although the  $\$11,800$  is only a 12.8% return on the total cost of  $\$92,000$ .

15. a. Profit =  $100,000x - (1,500,000 + 50,000x) = 0$   
 $50,000x = 1,500,000$   
 $x = 30$

b. Build the luxury boxes.

Profit =  $100,000 (50) - (1,500,000 + 50,000 (50))$   
 =  $\$1,000,000$

16. a. Max  $6x + 4y$

b.  $50x + 30y \leq 80,000$   
 $50x \leq 50,000$   
 $30y \leq 45,000$   
 $x, y \geq 0$

17. a.  $s_j = s_{j-1} + x_j - d_j$

or  $s_j - s_{j-1} - x_j + d_j = 0$

b.  $x_j \leq c_j$

c.  $s_j \geq I_j$