**Chapter 1**

**Introduction**

**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 breakeven point.

8. Obtain an introduction to the use of computer software packages such as *Microsoft Excel* in applying

quantitative methods to decision making.

9. Understand the following terms:

model infeasible solution

objective function management science

constraint operations research

deterministic model fixed cost

stochastic model variable cost

feasible solution breakeven point

**Solutions:**

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 Total Cost =

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

8. a. Maximize 10*x* + 5*y*

s.t.

5*x* + 2*y*  40

*x*  0, *y*  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 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 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 = 0.20*x* +0.25*y*

c. *x* + *y* = 5000

d. *x*  4000 Kansas City Constraint

*y*  3000 Minneapolis Constraint

e. Min 0.20*x* + 0.25*y*

s.t.

*x* +  *y* = 5000

*x*  4000

*y*  3000

*x*, *y*  0

11. a. At the $20 per-unit price, the firm can sell 800 – 10(20) = 600 units. At the $70 per-unit price, the firm can sell 800 – 10(70) = 100 units.

b. If the firm increases the per-unit price from $26 to $27, the annual demand for the product in units decreases from 800 – 10(26) = 540 to 800 – 10(27) = 530. If the firm increases the per-unit price from $42 to $43, the annual demand for the product in units decreases from 800 – 10(42) = 380 to 800 – 10(43) = 370. If the firm increases the per-unit price from $68 to $69, the annual demand for the product in units decreases from 800 – 10(68) = 120 to 800 – 10(69) = 110. These results suggest that a one dollar increase in price results in a 10 unit decrease in demand.

c. Since total revenue (TR) is the product of demand (*d*) and price (*p*), we have that *TR* = *dp* = (800 – 10*p*)*p* = 800*p* – 10*p*2.

d. At $30, *TR* = 800(30) – 10(30)2 = 24,000 – 10(900) = 15,000.

At $40, *TR* = 800(40) – 10(40)2 = 32,000 – 10(1600) = 16,000.

At $50, *TR* = 800(50) – 10(50)2 = 40,000 – 10(2500) = 15,000.

When considering price alternatives of $30, $40, and $50, total revenue is maximized at the $40 price (i.e., *p* = 40).

e. The expected annual demand and the total revenue according to the recommended price of $40 (from part d) are:

*d* = 800 – 10*p* = 800 – 10(40) = 400 units

*TR* = 800*p* – 10*p*2 = 800(40) – 10(40)2 = $16,000

12. a. If *x* represents the number of pairs of shoes produced, a mathematical model for the total cost of producing *x* pairs of shoes is *TC* = 2000 + 60*x*. The two components of total cost in this model are fixed cost ($2,000) and variable cost (60*x*).

b. If *P* represents the total profit, the total revenue (TR) is 80*x* and a mathematical model for the total profit realized from an order for *x* pairs of shoes is *P* = *TR* – *TC* = 80*x* – (2000+60*x*) = 20*x* – 2000.

c. The breakeven point is the number of shoes produced (*x*) at the point of no profit (*P* = 0).

Thus the breakeven point is the value of *x* when *P* = 20*x* – 2000 = 0. This occurs when 20*x* = 2000 or *x* = 100, i.e., the breakeven point is 100 pairs of shoes.

13. a. If *x* represents the number of students who enroll in the seminar, a model for the total cost to put on the seminar is 9600 + 60(2*x*) = 9600 + 120*x* (note that the variable cost per student is $60 per day, and the seminar is scheduled to last for two days, so total variable cost per student will be $120).

b. A model for the total profit if *x* students enroll in the seminar is total revenue (TR) – total cost (TC), which is 600*x* – (9600 + 120*x*) = 480*x* - 9600.

c. For Micromedia’s forecasted enrollment of 30 students, the seminar will earn 480(30) – 9600 = 4800 if its forecast is accurate.

d. The breakeven point is the number of shoes produced (*x*) at the point of no profit (*P* = 0).

Thus the breakeven point is the value of *x* when *P* = 480*x* - 9600 = 0. This occurs when 480*x* = 9600 or *x* = 20, i.e., the breakeven point for the seminar is 20 students.

14. a. If *x* represents the number of copies of the book that are sold, total revenue (TR) = 46*x* and total cost (TC) = 160,000 + 6*x*, so Profit = *TR* – *TC* = 46*x* – (160,000 + 6*x*) = 40*x* – 160,000. The breakeven point is the number of books produced (*x*) at the point of no profit (*P* = 0). Thus the breakeven point is the value of *x* when *P* = 40*x* - 160,000 = 0. This occurs when 40*x* = 160,000 or *x* = 4000, i.e., the breakeven point is 4000 copies of the book.

b. At a demand of 3800 copies, the publisher can expect a profit of 40(3800) – 160,000 = 152,000 – 160,000 = -8000, i.e., a loss of $8,000.

c. Here we know demand (*d* = 3800) and want to determine the price *p* at which we will breakeven (the point at which profit is 0). The minimum price per copy that the publisher must charge to break even is Profit = *p*(3800) – (160,000 + 6(3800)) = 3800*p* - 182,800. This occurs whre 3800*p* = 182,800 or *p* = 48.10526316 or a price of approximately $48.

d. If the publisher believes demand will remain at 4000 copies if the price per copy is increased to $50.95 , then the publisher could anticipate a profit of *TR* – *TC* = 50.95(4000) – (160,000 + 6(4000)) = 203,800 - 184,000 = 19,800 or a profit of $19,800. This is a return of *p*/*TC* = 10.8% on the total cost of $184,000, and the publisher should proceed if this return is sufficient.

15. a. If *x* represents the number of luxury boxes that are constructed, total revenue (TR) = 300,000*x* and total cost (TC) = 4,500,000 + 150,000*x*, so Profit = *TR* – *TC* = 300,000*x* – (4,500,000 + 150,000*x*) = 150,000*x* – 4,500,000. The breakeven point is the number of luxury boxes produced (*x*) at the point of no profit (*P* = 0). Thus the breakeven point is the value of *x* when *P* = 150,000*x* – 4,500,000 = 0. This occurs when 150,000*x* = 4,500,000 or *x* = 30, i.e., the breakeven point is 30 luxury boxes.

b. The anticipated profit from this decision is *P* = 150,000(50) – 4,500,000 = 7,500,000-4,500,000 = $3,000,000. Since this represents a return of *p*/*TC* = 25% on the total cost of $12,000,000, city officials should authorize construction of 50 luxury boxes.

16. a. The annual return per share of Oil Alaska is $6.00 and the annual return per share of Southwest Petroleum is $4.00, so the objective function that maximizes the total annual return is Max 6*x* + 4*y*.

b. The price per share of Oil Alaska is $50.00 and the price per share of Southwest Petroleum is $30.00, so

(1) the mathematical expression for the constraint that limits total investment funds to $800,000 is 50*x* + 30*y* ≤ 800000,

(2) the mathematical expression for the constraint that limits investment in Oil Alaska to $500,000 is 50*x* ≤ 500000, and

(3) the mathematical expression for the constraint that limits investment in Southwest Petroleum to $450,000 is 30*y* ≤ 450000.

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  *c*j

c. *s*j  *I*j