Chapter 1—Introduction

MULTIPLE CHOICE

1. The field of management science
   a. concentrates on the use of quantitative methods to assist in decision making.
   b. approaches decision making rationally, with techniques based on the scientific method.
   c. is another name for decision science and for operations research.
   d. each of these choices are true.

   ANS: D PTS: 1 TOP: Introduction

2. Identification and definition of a problem
   a. cannot be done until alternatives are proposed.
   b. is the first step of decision making.
   c. is the final step of problem solving.
   d. requires consideration of multiple criteria.

   ANS: B PTS: 1 TOP: Problem solving and decision making

3. Decision alternatives
   a. should be identified before decision criteria are established.
   b. are limited to quantitative solutions
   c. are evaluated as a part of the problem definition stage.
   d. are best generated by brain-storming.

   ANS: A PTS: 1 TOP: Problem solving and decision making

4. Decision criteria
   a. are the choices faced by the decision maker.
   b. are the problems faced by the decision maker.
   c. are the ways to evaluate the choices faced by the decision maker.
   d. must be unique for a problem.

   ANS: C PTS: 1 TOP: Problem solving and decision making

5. In a multicriteria decision problem
   a. it is impossible to select a single decision alternative.
   b. the decision maker must evaluate each alternative with respect to each criterion.
   c. successive decisions must be made over time.
   d. each of these choices are true.

   ANS: B PTS: 1 TOP: Problem solving and decision making

6. The quantitative analysis approach requires
   a. the manager's prior experience with a similar problem.
   b. a relatively uncomplicated problem.
   c. mathematical expressions for the relationships.

   ANS: C PTS: 1 TOP: Quantitative analysis and decision making

7. A physical model that does not have the same physical appearance as the object being modeled is
   a. an analog model.
   b. an iconic model.

c. a mathematical model.
d. a qualitative model.

ANS: A PTS: 1 TOP: Model development

8. Inputs to a quantitative model
   a. are a trivial part of the problem solving process.
   b. are uncertain for a stochastic model.
   c. are uncontrollable for the decision variables.
   d. must all be deterministic if the problem is to have a solution.

ANS: B PTS: 1 TOP: Model development

9. When the value of the output cannot be determined even if the value of the controllable input is known, the model is
   a. analog.
   b. digital.
   c. stochastic.
   d. deterministic.

ANS: C PTS: 1 TOP: Model development

10. The volume that results in total revenue being equal to total cost is the
    a. break-even point.
    b. marginal volume.
    c. marginal cost.
    d. profit mix.

ANS: A PTS: 1 TOP: Break-even analysis

11. Management science and operations research both involve
    a. qualitative managerial skills.
    b. quantitative approaches to decision making.
    c. operational management skills.
    d. scientific research as opposed to applications.

ANS: B PTS: 1 TOP: Introduction

12. George Dantzig is important in the history of management science because he developed
    a. the scientific management revolution.
    b. World War II operations research teams.
    c. the simplex method for linear programming.
    d. powerful digital computers.

ANS: C PTS: 1 TOP: Introduction

13. The first step in problem solving is
    a. determination of the correct analytical solution procedure.
    b. definition of decision variables.
    c. the identification of a difference between the actual and desired state of affairs.
    d. implementation.

ANS: C PTS: 1 TOP: Problem solving and decision making

14. Problem definition
    a. includes specific objectives and operating constraints.

b. must occur prior to the quantitative analysis process.
c. must involve the analyst and the user of the results.
d. each of these choices are true.

ANS: D PTS: 1 TOP: Quantitative analysis

15. A model that uses a system of symbols to represent a problem is called
a. mathematical.
b. iconic.
c. analog.
d. constrained.

ANS: A PTS: 1 TOP: Model development

TRUE/FALSE

1. The process of decision making is more limited than that of problem solving.

ANS: T PTS: 1 TOP: Problem solving and decision making

2. The terms 'stochastic' and 'deterministic' have the same meaning in quantitative analysis.

ANS: F PTS: 1 TOP: Model development

3. The volume that results in marginal revenue equaling marginal cost is called the break-even point.

ANS: F PTS: 1 TOP: Problem solving and decision making

4. Problem solving encompasses both the identification of a problem and the action to resolve it.

ANS: T PTS: 1 TOP: Problem solving and decision making

s 5. The decision making process includes implementation and evaluation of the decision.

ANS: F PTS: 1 TOP: Problem solving and decision making

6. The most successful quantitative analysis will separate the analyst from the managerial team until after the problem is fully structured.

ANS: F PTS: 1 TOP: Quantitative analysis

7. The value of any model is that it enables the user to make inferences about the real situation.

ANS: T PTS: 1 TOP: Model development

8. Uncontrollable inputs are the decision variables for a model.

ANS: F PTS: 1 TOP: Model development

9. The feasible solution is the best solution possible for a mathematical model.

ANS: F PTS: 1 TOP: Model solution

10. A company seeks to maximize profit subject to limited availability of man-hours. Man-hours is a controllable input.

    ANS: F PTS: 1 TOP: Model development

11. Frederick Taylor is credited with forming the first MS/OR interdisciplinary teams in the 1940's.

    ANS: F PTS: 1 TOP: Introduction

12. To find the choice that provides the highest profit and the fewest employees, apply a single-criterion decision process.

    ANS: F PTS: 1 TOP: Problem solving and decision making

13. The most critical component in determining the success or failure of any quantitative approach to decision making is problem definition.

    ANS: T PTS: 1 TOP: Quantitative analysis

14. The first step in the decision making process is to identify the problem.

    ANS: T PTS: 1 TOP: Introduction

15. All uncontrollable inputs or data must be specified before we can analyze the model and recommend a decision or solution for the problem.

    ANS: T PTS: 1 TOP: Quantitative analysis

16. In quantitative analysis, the optimal solution is the mathematically-best solution.

    ANS: T PTS: 1 TOP: Quantitative analysis

17. If you are deciding to buy either machine A, B, or C with the objective of minimizing the sum of labor, material and utility costs, you are dealing with a single-criterion decision.

    ANS: T PTS: 1 TOP: Problem solving and decision making

18. Model development should be left to quantitative analysts; the model user's involvement should begin at the implementation stage.

    ANS: F PTS: 1 TOP: Problem solving and decision making

19. A feasible solution is one that satisfies at least one of the constraints in the problem.

    ANS: F PTS: 1 TOP: Model solution

20. A toy train layout designed to represent an actual railyard is an example of an analog model.

    ANS: F PTS: 1 TOP: Model development

SHORT ANSWER

1. Should the problem solving process be applied to all problems?

ANS:
Answer not provided.

PTS: 1 TOP: Problem solving and decision making

2. Explain the difference between quantitative and qualitative analysis from the manager's point of view.

ANS:
Answer not provided.

PTS: 1 TOP: Quantitative analysis and decision making

3. Explain the relationship among model development, model accuracy, and the ability to obtain a solution from a model.

ANS:
Answer not provided.

PTS: 1 TOP: Model solution

4. What are three of the management science techniques that practitioners use most frequently? How can the effectiveness of these applications be increased?

ANS:
Answer not provided.

PTS: 1 TOP: Methods used most frequently

5. What steps of the problem solving process are involved in decision making?

ANS:
Answer not provided.

PTS: 1 TOP: Introduction

6. Give three benefits of model development and an example of each.

ANS:
Answer not provided.

PTS: 1 TOP: Model development

7. Explain the relationship between information systems specialists and quantitative analysts in the solution of large mathematical problems.

ANS:
Answer not provided.

PTS: 1 TOP: Data preparation

8. Define and contrast the terms feasible solution, infeasible solution and optimal solution.

ANS:

Answer not provided.

PTS: 1 TOP: Model solution

9. Define three forms of models and provide an example of each.

ANS:
Answer not provided.

PTS: 1 TOP: Model development

10. Explain the difference between controllable and uncontrollable inputs to a mathematical model and provide an example of each.

ANS:
Answer not provided.

PTS: 1 TOP: Model development

PROBLEM

1. A snack food manufacturer buys corn for tortilla chips from two cooperatives, one in Iowa and one in Illinois. The price per unit of the Iowa corn is $6.00 and the price per unit of the Illinois corn is $5.50.
   a. Define variables that would tell how many units to purchase from each source.
   b. Develop an objective function that would minimize the total cost.
   c. The manufacturer needs at least 12000 units of corn. The Iowa cooperative can supply up to 8000 units, and the Illinois cooperative can supply at least 6000 units. Develop constraints for these conditions.

ANS:

a. Let x_1 = the number of units from Iowa
Let x_2 = the number of units from Illinois
b. Min $6x_1 + 5.5x_2$
c. $x_1 + x_2 \geq 12000$
$x_1 \geq 8000$
$x_1 \geq 6000$

PTS: 1 TOP: Model development

2. The relationship d = 5000 – 25p describes what happens to demand (d) as price (p) varies. Here, price can vary between $10 and $50.
   a. How many units can be sold at the $10 price? How many can be sold at the $50 price?
   b. Model the expression for total revenue.
   c. Consider prices of $20, $30, and $40. Which of these three price alternative will maximize total revenue? What are the values for demand and revenue at this price?

ANS:

a. For p = 10, d = 4750
For p = 50, d = 3750
b. TR = p(5000 – 25p)

c. For p = 20, d = 4500, TR = $90,000
For p = 30, d = 4250, TR = $127,500
For p = 40, d = 4000, TR = $160,000 (maximum total revenue)

PTS: 1 TOP: Model development

3. There is a fixed cost of $50,000 to start a production process. Once the process has begun, the variable cost per unit is $25. The revenue per unit is projected to be $45.
   a. Write an expression for total cost.
   b. Write an expression for total revenue.
   c. Write an expression for total profit.
   d. Find the break-even point.

ANS:

a. $C(x) = 50000 + 25x$
b. $R(x) = 45x$
c. $P(x) = 45x – (50000 + 25x)$
d. $x = 2500$

PTS: 1 TOP: Break-even analysis

4. An author has received an advance against royalties of $10,000. The royalty rate is $1.00 for every book sold in the United States, and $1.35 for every book sold outside the United States. Define variables for this problem and write an expression that could be used to calculate the number of books to be sold to cover the advance.

ANS:
Let x_1 = the number of books sold in the U.S.
Let x_2 = the number of books sold outside the U.S.

$10000 = 1x_1 + 1.35x_2$

PTS: 1 TOP: Break-even analysis

5. A university schedules summer school courses based on anticipated enrollment. The cost for faculty compensation, laboratories, student services, and allocated overhead for a computer class is $8500. If students pay $920 to enroll in the course, how large would enrollment have to be for the university to break even?

ANS:
Enrollment would need to be 10 students.

PTS: 1 TOP: Break-even analysis

6. As part of their application for a loan to buy Lakeside Farm, a property they hope to develop as a bed-and-breakfast operation, the prospective owners have projected:

Monthly fixed cost (loan payment, taxes, insurance, maintenance)	$6000
Variable cost per occupied room per night	$ 20
Revenue per occupied room per night	$ 75

a. Write the expression for total cost per month. Assume 30 days per month.

b. Write the expression for total revenue per month.
c. If there are 12 guest rooms available, can they break even? What percentage of rooms would need to be occupied, on average, to break even?

ANS:

a. C(x) = 6000 + 20(30)x (monthly)
b. R(x) = 75(30)x (monthly)
c. Break-even occupancy = 3.64 or 4 occupied rooms per night, so they have enough rooms to break even. This would be a 33% occupancy rate.

PTS: 1 TOP: Break-even analysis

7. Organizers of an Internet training session will charge participants $150 to attend. It costs $3000 to reserve the room, hire the instructor, bring in the equipment, and advertise. Assume it costs $25 per student for the organizers to provide the course materials.
a. How many students would have to attend for the company to break even?
b. If the trainers think, realistically, that 20 people will attend, then what price should be charged per person for the organization to break even?

ANS:

a. C(x) = 3000 + 25x
R(x) = 150x
Break-even students = 24
b. Cost = 3000 + 25(20)
Revenue = 20p
Break-even price = 175

PTS: 1 TOP: Break-even analysis

8. In this portion of an Excel spreadsheet, the user has given values for selling price, the costs, and a sample volume. Give the cell formula for
a. cell E12, break-even volume.
b. cell E16, total revenue.
c. cell E17, total cost.
d. cell E19, profit (loss).

	A	B	C	D	E
1					
2					
3					
4	Break-even calculation				
5					
6		Selling price per unit			10
7					
8		Costs			
9		Fix cost			8400
10		Variable cost per unit			4.5
11					
12		Break-even volume			
13					

14		Sample calculation	
15		Volume	2000
16		Total revenue	
17		Total cost	
18			
19		Profit (loss)	

ANS:

a. =E9/(E6-E10)
b. =E15*E6
c. =E9+E10*E15
d. =E16-E17

PTS: 1 TOP: Spreadsheets for management science

9. A furniture store has set aside 800 square feet to display its sofas and chairs. Each sofa utilizes 50 sq. ft. and each chair utilizes 30 sq. ft. At least five sofas and at least five chairs are to be displayed.
   a. Write a mathematical model representing the store's constraints.
   b. Suppose the profit on sofas is \$200 and on chairs is \$100. On a given day, the probability that a displayed sofa will be sold is .03 and that a displayed chair will be sold is .05. Mathematically model each of the following objectives:
      1. Maximize the total pieces of furniture displayed.
      2. Maximize the total expected number of daily sales.
      3. Maximize the total expected daily profit.

ANS:

a. $50s + 30c \le 800$
   $s \ge 5$
   $c \ge 5$
b. (1) Max $s + c$
   (2) Max $.03s + .05c$
   (3) Max $6s + 5c$

PTS: 1 TOP: Model development

10. A manufacturer makes two products, doors and windows. Each must be processed through two work areas. Work area #1 has 60 hours of available production time per week. Work area #2 has 48 hours of available production time per week. Manufacturing of a door requires 4 hours in work area #1 and 2 hours in work area #2. Manufacturing of a window requires 2 hours in work area #1 and 4 hours in work area #2. Profit is \$8 per door and \$6 per window.
    a. Define decision variables that will tell how many units to build (doors and windows) per week.
    b. Develop an objective function that will maximize total profit per week.
    c. Develop production constraints for work area #1 and #2.

ANS:

a. Let D = the number of doors to build per week
   Let N = the number of windows to build per week
b. Weekly Profit = 8D + 6W

c. $4D + 2W \le 60$
$2D + 4W \le 48$

PTS: 1 TOP: Model development

11. A small firm builds galvanized swing sets. The investment in plant and equipment is $200,000. The variable cost per swing set is $500. The selling price of the swing set is $1000. How many swing sets would have to be sold for the firm to break even?

ANS:
400 swing sets

PTS: 1 TOP: Break-even analysis

12. A computer rework center has the capacity to rework 300 computers per day. The expected number of computers needing to be reworked per day is 225. The center is paid $26 for each computer reworked. The fixed cost of renting the reworking equipment is $250 per day. Work space rents for $150 per day. The cost of material is $18 per computer and labor costs $3 per computer. What is the break-even number of computers reworked per day?

ANS:
80 computers

PTS: 1 TOP: Break-even analysis

13. To establish a driver education school, organizers must decide how many cars, instructors, and students to have. Costs are estimated as follows. Annual fixed costs to operate the school are $30,000. The annual cost per car is $3000. The annual cost per instructor is $11,000 and one instructor is needed for each car. Tuition for each student is $350. Let x be the number of cars and y be the number of students.

a. Write an expression for total cost.
b. Write an expression for total revenue.
c. Write an expression for total profit.
d. The school offers the course eight times each year. Each time the course is offered, there are two sessions. If they decide to operate five cars, and if four students can be assigned to each car, will they break even?

ANS:

a. $C(x) = 30000 + 14000x$
b. $R(y) = 350y$
c. $P(x,y) = 350y - (30000 + 14000x)$
d. Each car/instructor can serve up to (4 students/session)(2 sessions/course)(8 courses/year) = 64 students annually. Five cars can serve 320 students. If the classes are filled, then profit for five cars is

$$350(320) - (30000 + 14000(5)) = 12000$$

so the school can reach the break-even point.

PTS: 1 TOP: Break-even analysis

14. Zipco Printing operates a shop that has five printing machines. The machines differ in their capacities to perform various printing operations due to differences in the machines' designs and operator skill levels. At the start of the workday there are five printing jobs to schedule. The manager must decide what the job-machine assignments should be.
    a. How could a quantitative approach to decision making be used to solve this problem?
    b. What would be the uncontrollable inputs for which data must be collected?
    c. Define the decision variables, objective function, and constraints to appear in the mathematical model.
    d. Is the model deterministic or stochastic?
    e. Suggest some simplifying assumptions for this problem.

    ANS:

    a. A quantitative approach to decision making can provide a systematic way for deciding the job-machine pairings so that total job processing time is minimized.
    b. How long it takes to process each job on each machine, and any job-machine pairings that are unacceptable.
    c. <u>Decision variables:</u> one for each job-machine pairing, taking on a value of 1 if the pairing is used and 0 otherwise.
       <u>Objective function:</u> minimize total job processing time.
       <u>Constraints:</u> each job is assigned to exactly one machine, and each machine be assigned no more than one job.
    d. Stochastic: job processing times vary due to varying machine set-up times, variable operator performance, and more.
    e. Assume that processing times are deterministic (known/fixed).

    PTS: 1 TOP: Model development

15. Consider a department store that must make weekly shipments of a certain product from two different warehouses to four different stores.
    a. How could a quantitative approach to decision making be used to solve this problem?
    b. What would be the uncontrollable inputs for which data must be gathered?
    c. What would be the decision variables of the mathematical model? the objective function? the constraints?
    d. Is the model deterministic or stochastic?
    e. Suggest assumptions that could be made to simplify the model.

    ANS:

    a. A quantitative approach to decision making can provide a systematic way to determine a minimum shipping cost from the warehouses to the stores.
    b. Fixed costs and variable shipping costs; the demand each week at each store; the supplies each week at each warehouse.
    c. Decision variables--how much to ship from each warehouse to each store; objective function--minimize total shipping costs; constraints--meet the demand at the stores without exceeding the supplies at the warehouses.
    d. Stochastic--weekly demands fluctuate as do weekly supplies; transportation costs could vary depending upon the amount shipped, other goods sent with a shipment, etc.
    e. Make the model deterministic by assuming fixed shipping costs per item, demand is constant at each store each week, and weekly supplies in the warehouses are constant.

    PTS: 1 TOP: Model development