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 the above is true.

ANSWER: d
TOPIC: 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.

ANSWER: b
TOPIC: 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.

ANSWER: a
TOPIC: 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.

ANSWER: c
TOPIC: 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 the above is true.

ANSWER: b
TOPIC: 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.
   d. each of the above is true.

ANSWER: c
TOPIC: 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.

ANSWER: a
TOPIC: 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.

ANSWER: b
TOPIC: 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.

ANSWER: c
TOPIC: 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.

ANSWER: a
TOPIC: 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.

ANSWER: b
TOPIC: 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.
ANSWER: c
TOPIC: 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.
ANSWER: c
TOPIC: 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 the above is true.
ANSWER: d
TOPIC: 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.
ANSWER: a
TOPIC: Model development

TRUE/FALSE

1. The process of decision making is more limited than that of problem solving.
ANSWER: True
TOPIC: Problem solving and decision making

2. The terms ‘stochastic’ and ‘deterministic’ have the same meaning in quantitative analysis.
ANSWER: False
TOPIC: Model development

3. The volume that results in marginal revenue equaling marginal cost is called the break-even point.
ANSWER: False
TOPIC: Problem solving and decision making

4. Problem solving encompasses both the identification of a problem and the action to resolve it.
ANSWER: True
TOPIC: Problem solving and decision making

5. The decision making process includes implementation and evaluation of the decision.
ANSWER: False
TOPIC: 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.
ANSWER: False
TOPIC: Quantitative analysis

7. The value of any model is that it enables the user to make inferences about the real situation.
ANSWER: True
TOPIC: Model development

8. Uncontrollable inputs are the decision variables for a model.
ANSWER: False
TOPIC: Model development

9. The feasible solution is the best solution possible for a mathematical model.
ANSWER: False
TOPIC: Model solution

10. A company seeks to maximize profit subject to limited availability of man-hours. Man-hours is a controllable input.
ANSWER: False
TOPIC: Model development

11. Frederick Taylor is credited with forming the first MS/OR interdisciplinary teams in the 1940's.
ANSWER: False
TOPIC: Introduction

12. To find the choice that provides the highest profit and the fewest employees, apply a single-criterion decision process.
ANSWER: False
TOPIC: 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.
ANSWER: True
TOPIC: Quantitative analysis

14. The first step in the decision making process is to identify the problem.
ANSWER: True
TOPIC: 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.
ANSWER: True
TOPIC: Quantitative analysis

SHORT ANSWER

1. Should the problem solving process be applied to all problems?
TOPIC: Problem solving and decision making

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

TOPIC: Quantitative analysis and decision making

3. Explain the relationship among model development, model accuracy, and the ability to obtain a solution from a model.
TOPIC: 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?
TOPIC: Methods used most frequently

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

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

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

PROBLEMS

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.

TOPIC: 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 price alternative will maximize total revenue? What are the values for demand and revenue at this price?

TOPIC: 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.

TOPIC: 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.

TOPIC: 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 $420 to enroll in the course, how large would enrollment have to be for the university to break even?

TOPIC: 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?

TOPIC: 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?

TOPIC: 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		Fixed 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			

TOPIC: 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.

TOPIC: 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. Work area #2 has 48 hours of available production time. 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).
    b. Develop an objective function that will maximize profits.
    c. Develop production constraints for work area #1 and #2.

TOPIC: Model development

11. A small firm builds television antennas. The investment in plan and equipment is $200,000. The variable cost per television antenna is $500. The price of the television antenna is $1000. How many television antennas would be needed for the firm to break even?

TOPIC: Break-even analysis

12. As computer service center has the capacity to do 400 jobs per day. The expected level of jobs demanded per day is 250 per day. The fixed cost of renting the computer process is $200 per day. Space rents for $100 per day. The cost of material is $15 per unit of work and $.35 cents of labor per unit. What is the break-even level of work?

TOPIC: 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 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?

TOPIC: Break-even analysis

SOLUTIONS TO PROBLEMS

1. 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. $x_1 + x_2 \geq 12000$
   $x_1 \geq 8000$
   $x_1 \geq 6000$

2. a. For p = 10, d = 4750
   For p = 50, d = 3750
   b. TR = p(5000-25p)
   c. For p = 20, TR = $90,000
   For p = 30, TR = $127,500
   For p = 40, TR = $160,000
   Best price is p = 40. Demand = 4000

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

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

   $10000 = 1x_1 + 1.35x_2$

5. Enrollment would need to be 21 students.

6. 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.

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

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

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

10. a. Let D = the number of doors to build
   Let N = the number of windows to build

b. Profit = 8D + 6W
c. $4D + 2W \leq 60$
$2D + 4W \leq 48$

11. 400 television antennae

12. 200 service units

13. 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.