CHAPTER 1

Introduction to Quantitative Analysis

TEACHING SUGGESTIONS

Teaching Suggestion 1.1: *Importance of Qualitative Factors.*

Section 1.2 gives students an overview of quantitative analysis. In this section, a number of qualitative factors, including federal legislation and new technology, are discussed. Students can be asked to discuss other qualitative factors that could have an impact on quantitative analysis. Waiting lines and project planning can be used as examples.

Teaching Suggestion 1.2: *Discussing Other Quantitative Analysis Problems.*

Section 1.2 covers an application of the quantitative analysis approach. Students can be asked to describe other problems or areas that could benefit from quantitative analysis.

Teaching Suggestion 1.3: *Discussing Conflicting Viewpoints.*

Possible problems in the QA approach are presented in this chapter. A discussion of conflicting viewpoints within the organization can help students understand this problem. For example, how many people should staff a registration desk at a university? Students will want more staff to reduce waiting time, while university administrators will want less staff to save money. A discussion of these types of conflicting viewpoints will help students understand some of the problems of using quantitative analysis.

Teaching Suggestion 1.4: *Difficulty of Getting Input Data.*

A major problem in quantitative analysis is getting proper input data. Students can be asked to explain how they would get the information they need to determine inventory ordering or carrying costs. Role-playing with students assuming the parts of the analyst who needs inventory costs and the instructor playing the part of a veteran inventory manager can be fun and interesting. Students quickly learn that getting good data can be the most difficult part of using quantitative analysis.

Teaching Suggestion 1.5: *Dealing with Resistance to Change.*

Resistance to change is discussed in this chapter. Students can be asked to explain how they would introduce a new system or change within the organization. People resisting new approaches can be a major stumbling block to the successful implementation of quantitative analysis. Students can be asked why some people may be afraid of a new inventory control or forecasting system.

SOLUTIONS TO DISCUSSION QUESTIONS AND PROBLEMS

1-1. Through an approach that is scientific, logical and rational and hence avoids reliance on guesswork, subjective opinions and intuition.

1-2. Quantitative analysis is the scientific approach to managerial decision making. This type of analysis is a logical and rational approach to making decisions. Emotions, guesswork, and whim are not part of the quantitative analysis approach. A number of organizations support the use of the scientific approach: the Institute for Operation Research and Management Science (INFORMS), Decision Sciences Institute, and Academy of Management.

1-3. The three categories of business analytics are descriptive, predictive, and prescriptive. Descriptive analytics provides an indication of how things performed in the past. Predictive analytics uses past data to forecast what will happen in the future. Prescriptive analytics uses optimization and other models to present better ways for a company to operate to reach goals and objectives.

1-4. The 7 steps are as follows:

- Defining the problem.
- Developing a Model.
- Acquiring Input Data.
- Developing a Solution.
- Testing the Solution.
- Analyzing the Results.
- Implementing the Results.

1-5. Although the formal study of quantitative analysis and the refinement of the tools and techniques of the scientific method have occurred only in the recent past, quantitative approaches to decision making have been in existence since the beginning of time. In the early 1900s, Frederick W. Taylor developed the principles of the scientific approach. During World War II, quantitative analysis was intensified and used by the military. Because of the success of these techniques during World War II, interest continued after the war.

1-6. Quantitative analysis involves the use of mathematical equations or relationships in analyzing a particular problem. In most cases, the results of quantitative analysis will be one or more numbers that can be used by managers and decision makers in making better decisions.
(1) Defining the Problem, (2) Developing a Model, (3) Acquiring Input Data, (4) Developing a Solution, (5) Testing the Solution, (6) Analyzing the Results, and (7) Implementing the Results.

1-7. Input data can come from company reports and documents, interviews with employees and other personnel, direct measurement, and sampling procedures. For many problems, a number of different sources are required to obtain data, and in some cases it is necessary to obtain the same data from different sources in order to check the accuracy and consistency of the input data. If the input data are not accurate, the results can be misleading and very costly to the organization. This concept is called “garbage in, garbage out”.

1-8. Implementation is the process of taking the solution and incorporating it into the company or organization. This is the final step in the quantitative analysis approach, and if a good job is not done with implementation, all of the effort expended on the previous steps can be wasted.

1-9. The phrase 'Garbage in, garbage out' highlights the importance of acquiring accurate input data. If the input data is inaccurate then no matter how good the model, the results produced will be misleading.

1-10. There are a large number of quantitative terms that may not be understood by managers. Examples include PERT, CPM, simulation, the Monte Carlo method, mathematical programming, EOQ, and so on. The student should explain each of the four terms selected in his or her own words.

1-11. Answers will vary but may include: (1) lack of commitment by management, (2) resistance to change by management, and (3) lack of commitment by quantitative analysts.

1-12. Users need not become involved in technical aspects of the QA technique, *but* they should have an understanding of what the limitations of the model are, how it works (in a general sense), the jargon involved, and the ability to question the validity and sensitivity of an answer handed to them by an analyst.

1-13. Churchman meant that sophisticated mathematical solutions and proofs can be dangerous because people may be afraid to question them. Many people do not want to appear ignorant and question an elaborate mathematical model; yet the entire model, its assumptions and its approach, may be incorrect.

1-14. The break-even point is the number of units that must be sold to make zero profits. To compute this, we must know the selling price, the fixed cost, and the variable cost per unit.

1-15. $f = 350$ $s = 15$ $v = 8$

a) Total revenue = 20(15) = $300

Total variable cost = 20(8) = $160

b) BEP = $f/(s - v)$ = 350/(15 − 8) = 50 units

Total revenue = 50(15) = $750

1-16. $f = 150$ $s = 50$ $v = 20$

BEP = $f/(s - v)$ = 150/(50 − 20) = 5 units

1-17. $f = 150$ $s = 50$ $v = 15$

BEP = $f/(s - v)$ = 150/(50 − 15) = 4.29 units

1-18. $f = 400 + 1{,}000 = 1{,}400$ $s = 5$ $v = 3$

BEP = $f/(s - v)$ = 1400/(5 − 3) = 700 units

1-19. BEP = $f/(s - v)$

$500 = 1400/(s - 3)$

$500(s - 3) = 1400$

$s - 3 = 1400/500$

$s = 2.8 + 3$

$s = \$5.80$

1-20. $f = 2400$ $s = 40$ $v = 25$

BEP = $f/(s - v)$ = 2400/(40 – 25) = 160 per week

Total revenue = 40(160) = $6400

1-21. $f = 2400$ $s = 50$ $v = 25$

BEP = $f/(s - v)$ = 2400/(50 – 25) = 96 per week

Total revenue = 50(96) = $4800

1-22. $f = 2400$ $s = ?$ $v = 25$

BEP = $f/(s - v)$

$120 = 2400/(s - 25)$

$120(s - 25) = 2400$

$s = 45$

1-23. $f = 11000$ $s = 250$ $v = 60$

BEP = $f/(s - v)$ = 11000/(250 – 60) = 57.9

1-24. a) $f = 300 + 75 = 375$ $s = 20$ $v = 5$

BEP = $f/(s - v)$ = 375/(20 – 5) = 25

b) $f = 200 + 75 = 275$ $s = 20$ $v = 5$

BEP = $f/(s - v)$ = 275/(20 − 5) = 18.333

1-25. a) Machine 1: $f = 600$ $s = 0.05$ $v = 0.010$

BEP = $f/(s - v)$ = 600/(0.05 – 0.010) = 15,000

Machine 2: $f = 400$ $s = 0.05$ $v = 0.015$

BEP = $f/(s - v)$ = 400/(0.05 – 0.015) = 11,428.57

b) Machine 1: Cost = 600 + 0.010(10,000) = $700

Machine 2: Cost = 400 + 0.015(10,000) = $550

c) Machine 1: Cost = 600 + 0.010(30,000) = $900

Machine 2: Cost = 400 + 0.015(30,000) = $850

d) Let X = the number of copies

600 + 0.010X = 400 + 0.015X

600 – 400 = 0.015X – 0.010X

200 = 0.05X

X = 40,000 copies

1-26. a) Proposal A: $f = 65{,}000$ $s = 18$ $v = 10$

BEP = $f/(s - v) = 65{,}000/(18 - 10) = 8{,}125$

Proposal B: $f = 34{,}000$ $s = 18$ $v = 14$

BEP = $f/(s - v) = 34{,}000/(18 - 14) = 8{,}500$

b) Proposal A should be chosen.

SOLUTION TO FOOD AND BEVERAGES AT SOUTHWESTERN UNIVERSITY FOOTBALL GAMES

The total fixed cost per game includes salaries, rental fees, and cost of the workers in the six booths. These are:

Salaries = $20,000

Rental fees = 2,400 × $2 = $4,800

Booth worker wages = 6 × 6 × 5 × $7 = $1,260

Total fixed cost per game = $20,000 + $4,800 + $1,260 = $26,060

The cost of this allocated to each food item is shown in the table:

Item	Percent revenue	Allocated fixed cost
Soft drink	25%	$6,515
Coffee	25%	$6,515
Hot dogs	20%	$5,212
Hamburgers	20%	$5,212
Misc. snacks	10%	$2,606

The break-even points for each of these items are found by computing the contribution to profit (profit margin) for each item and dividing this into the allocated fixed cost. These are shown in the next table:

Item	Selling price	Var. cost	Profit margin	Percent revenue	Allocated fixed cost	Break even volume
Soft drink	$1.50	$0.75	$0.75	25%	6515	8686.67
Coffee	$2.00	$0.50	$1.50	25%	6515	4343.33
Hot dogs	$2.00	$0.80	$1.20	20%	5212	4343.33
Hamburgers	$2.50	$1.00	$1.50	20%	5212	3474.67
Misc. snacks	$1.00	$0.40	$0.60	10%	2606	4343.33

To determine the total sales for each item that is required to break even, multiply the selling price by the break even volume. The results are shown:

Item	Selling price	Break even volume	Dollar volume of sales
Soft drink	$1.50	8686.67	$13,030.00
Coffee	$2.00	4343.33	$8,686.67
Hot dogs	$2.00	4343.33	$8,686.67
Hamburgers	$2.50	3474.67	$8,686.67
Misc. snacks	$1.00	4343.33	$4,343.33
Total			$43,433.34

Thus, to break even, the total sales must be $43,433.34. If the attendance is 35,000 people, then each person would have to spend $43,433.34/35,000 = $1.24. If the attendance is 60,000, then each person would have to spend $43,433.34/60,000 = $0.72. Both of these are very low values, so we should be confident that this food and beverage operation will at least break even.

Note: While this process provides information about break-even points based on the current percent revenues for each product, there is one difficulty. The total revenue using the break-even points will not result in the same percentages (dollar volume of product/total revenue) as originally stated in the problem. A more complex model is available to do this (see p. 308 Jay Heizer and Barry Render, *Principles of Operations Management*, 9th ed., Upper Saddle River, NJ: Prentice Hall, 2014).