11. You are designing a grocery delivery business. Via the Internet, your company will offer staples and frozen foods in a large metropolitan area and then deliver them within a customer-defined window of time. You plan to partner with two major food stores in the area. What should be your competitive priorities and what capabilities do you want to develop in your core and support processes?

Problems

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1. (Refer to Solved Problem 1.) Coach Bjourn Toulouse led the Big Red Herrings to several disappointing football seasons. Only better recruiting will return the Big Red Herrings to winning form. Because of the current state of the program, Boehring University fans are unlikely to support increases in the $192 season ticket price. Improved recruitment will increase overhead costs to $30,000 per class section from the current $25,000 per class section. The university's budget plan is to cover recruitment costs by increasing the average class size to 75 students. Labor costs will increase to $6,500 per 3-credit course. Material costs will be about $25 per student for each 3-credit course. Tuition will be $200 per semester credit, which is supplemented by state support of $100 per semester credit.

   a. What is the multifactor productivity ratio? Compared to the result obtained in Solved Problem 1, did productivity increase or decrease for the course process?

   b. If instructors work an average of 20 hours per week for 16 weeks for each 3-credit class of 75 students, what is the *labor* productivity ratio?

2. Suds and Duds Laundry washed and pressed the following numbers of dress shirts per week.

Week	Work Crew	Total Hours	Shirts
1	Sud and Dud	24	68
2	Sud and Jud	46	130
3	Sud, Dud, and Jud	62	152
4	Sud, Dud, and Jud	51	125
5	Dud and Jud	45	131

   a. Calculate the *labor* productivity ratio for each week.

   b. Explain the labor productivity pattern exhibited by the data.

3. CD players are produced on an automated assembly line process. The standard cost of CD players is $150 per unit (labor, $30; materials, $70; and overhead, $50). The sales price is $300 per unit.

   a. To achieve a 10 percent multifactor productivity improvement by reducing materials costs only, by what percentage must these costs be reduced?

   b. To achieve a 10 percent multifactor productivity improvement by reducing labor costs only, by what percentage must these costs be reduced?

   c. To achieve a 10 percent multifactor productivity improvement by reducing overhead costs only, by what percentage must these costs be reduced?

4. The output of a process is valued at $100 per unit. The cost of labor is $50 per hour including benefits. The accounting department provided the following information about the process for the past four weeks:

	Week 1	Week 2	Week 3	Week 4
Units Produced	1,124	1,310	1,092	981
Labor ($)	12,735	14,842	10,603	9,526
Material ($)	21,041	24,523	20,442	18,364
Overhead ($)	8,992	10,480	8,736	7,848

   a. Use the multifactor productivity ratio to see whether recent process improvements had any effect and, if so, when the effect was noticeable.

   b. Has labor productivity changed? Use the labor productivity ratio to support your answer.

5. Alyssa's Custom Cakes currently sells 5 birthday, 2 wedding, and 3 specialty cakes each month for $50, $150, and $100 each, respectively. The cost of labor is $50 per hour including benefits. It takes 90 minutes to produce a birthday cake, 240 minutes to produce a wedding cake, and 60 minutes to produce a specialty cake. Alyssa's current multifactor productivity ratio is 1.25.

   a. Use the multifactor productivity ratio provided to calculate the average cost of the cakes produced.

   b. Calculate Alyssa's labor productivity ratio in dollars per hour for each type of cake.

   c. Based solely on the labor productivity ratio, which cake should Alyssa try to sell the most?

   d. Based on your answer in part (a), is there a type of cake Alyssa should stop selling?

Advanced Problems

6. The Big Black Bird Company (BBBC) has a large order for special plastic-lined military uniforms to be used in an urgent military operation. Working the normal two shifts of 40 hours each per week, the BBBC production process usually produces 2,500 uniforms per week at a standard cost of $120 each. Seventy employees work the first shift and 30 employees work the second. The contract price is $200 per uniform. Because of the urgent need, BBBC is authorized to use around-the-clock production, 6 days per week. When each of the two shifts works 72 hours per week, production increases to 4,000 uniforms per week but at a cost of $144 each.

   a. Did the multifactor productivity ratio increase, decrease, or remain the same? If it changed, by what percentage did it change?

   b. Did the labor productivity ratio increase, decrease, or remain the same? If it changed, by what percentage did it change?

   c. Did weekly profits increase, decrease, or remain the same?

7. Mack's guitar fabrication shop produces low-cost, highly durable guitars for beginners. Typically, out of the 100 guitars that begin production each month, only 80 percent are considered good enough to sell. The other 20 percent are scrapped due to quality problems that are identified after they have completed the production process. Each guitar sells for $250. Because some of the production process is automated, each guitar only requires 10 labor hours. Each employee works an average 160 hours per month. Labor is paid at $10/hour, materials cost is $40/guitar, and overhead is $4,000.

   a. Calculate the labor and multifactor productivity ratios.

   b. After some study, the operations manager Darren Funk recommends three options to improve the company's multifactor productivity: (1) increase the sales price by 10 percent, (2) improve quality so that only 10 percent are defective, or (3) reduce labor, material, and overhead costs by 10 percent. Which option has the greatest impact on the multifactor productivity measure?

8. Mariah Enterprises makes a variety of consumer electronic products. Its camera manufacturing plant is considering choosing between two different processes, named Alpha and Beta, which can be used to make a component part. To make the correct decision, the managers would like to compare the labor and multifactor productivity of process Alpha with that of process Beta. The value of process output for Alpha and Beta is $175 and $140 per unit, and the corresponding overhead costs are $6,000 and $5,000, respectively.

	PROCESS ALPHA		PROCESS BETA	
Product	A	B	A	B
Output (units)	50	60	30	80
Labor ($)	$1,200	$1,400	$1,000	$2,000
Material ($)	$2,500	$3,000	$1,400	$3,500

   a. Which process, Alpha or Beta, is more productive?

   b. What conclusions can you draw from your analysis?

9. The Morning Brew Coffee Shop sells Regular, Cappuccino, and Vienna blends of coffee. The shop's current daily labor cost is $320, the equipment cost is $125, and the overhead cost is $225. Daily demands, along with selling price and material costs per beverage, are given below.

	Regular Coffee	Cappuccino	Vienna coffee
Beverages sold	350	100	150
Price per beverage	$2.00	$3.00	$4.00
Material ($)	$0.50	$0.75	$1.25

Harald Luckerbauer, the manager at Morning Brew Coffee Shop, would like to understand how adding Eiskaffee (a German coffee beverage of chilled coffee, milk, sweetener, and vanilla ice cream) will alter the shop's productivity. His market research shows that Eiskaffee will bring in new customers and not cannibalize current demand. Assuming that the new equipment is purchased before Eiskaffee is added to the menu, Harald has developed new average daily demand and cost projections. The new equipment cost is $200, and the overhead cost is $350. Modified daily demands, as well as selling price and material costs per beverage for the new product line, are given below.

	Regular Coffee	Cappuccino	Vienna coffee	Eiskaffee
Beverages sold	350	100	150	75
Price per beverage	$2.00	$3.00	$4.00	$5.00
Material ($)	$0.50	$0.75	$1.25	$1.50

   a. Calculate the change in labor and multifactor productivity if Eiskaffee is added to the menu.

   b. If everything else remains unchanged, how many units of Eiskaffee would have to be sold to ensure that the multifactor productivity increases from its current level?

SOLUTION

The decision tree is shown in Figure A.7. The payoff ($000) for each alternative-event branch is shown in the following table. The total revenues from one lift operating at 100 percent capacity are $490,000 (or 250 customers × 98 days × $20/customer-day).

Alternative	Economic Condition	Payoff Calculation (Revenue − Cost)
One lift	Bad times	0.9(490) − (50 + 200) = 191
	Normal times	1.0(490) − (50 + 200) = 240
	Good times	1.0(490) − (50 + 200) = 240
Two lifts	Bad times	0.9(490) − (90 + 200) = 151
	Normal times	1.5(490) − (90 + 400) = 245
	Good times	1.9(490) − (90 + 400) = 441
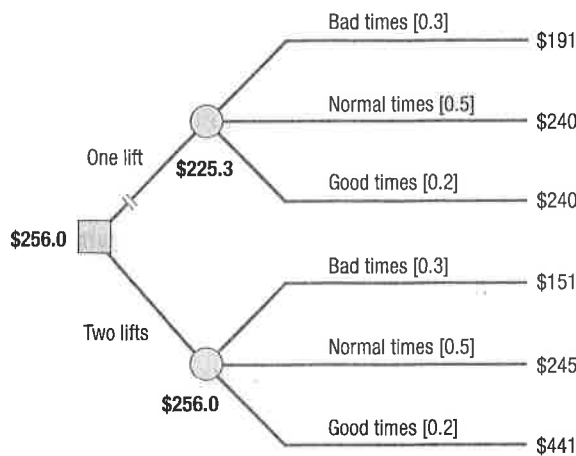
◀ **FIGURE A.7**

Problems

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BREAK-EVEN ANALYSIS

1. Mary Williams, owner of Williams Products, is evaluating whether to introduce a new product line. After thinking through the production process and the costs of raw materials and new equipment, Williams estimates the variable costs of each unit produced and sold at $6 and the fixed costs per year at $60,000.

   a. If the selling price is set at $18 each, how many units must be produced and sold for Williams to break even? Use both graphic and algebraic approaches to get your answer.

   b. Williams forecasts sales of 10,000 units for the first year if the selling price is set at $14 each. What would be the total contribution to profits from this new product during the first year?

   c. If the selling price is set at $12.50, Williams forecasts that first-year sales would increase to 15,000 units. Which pricing strategy ($14.00 or $12.50) would result in the greater total contribution to profits?

   d. What other considerations would be crucial to the final decision about making and marketing the new product?

2. A product at the Jennings Company enjoyed reasonable sales volumes, but its contributions to profits were disappointing. Last year, 17,500 units were produced and sold. The selling price is $22 per unit, the variable cost is $18 per unit, and the fixed cost is $80,000.

   a. What is the break-even quantity for this product? Use both graphic and algebraic approaches to get your answer.

   b. If sales were not expected to increase, by how much would Jennings have to reduce their variable cost to break even?

c. Jennings believes that a $1 reduction in price will increase sales by 50 percent. Is this enough for Jennings to break even? If not, by how much would sales have to increase?

d. Jennings is considering ways to either stimulate sales volume or decrease variable cost. Management believes that either sales can be increased by 30 percent or that variable cost can be reduced to 85 percent of its current level. Which alternative leads to higher contributions to profits, assuming that each is equally costly to implement? (Hint: Calculate profits for both alternatives and identify the one having the greatest profits.)

e. What is the percent change in the per-unit profit contribution generated by each alternative in part (d)?

3. An interactive television service that costs $10 per *month* to provide can be sold on the information highway for $15 per client per *month*. If a service area includes a potential of 15,000 customers, what is the most a company could spend on *annual* fixed costs to acquire and maintain the equipment?

4. A restaurant is considering adding fresh brook trout to its menu. Customers would have the choice of catching their own trout from a simulated mountain stream or simply asking the waiter to net the trout for them. Operating the stream would require $10,600 in fixed costs per year. Variable costs are estimated to be $6.70 per trout. The firm wants to break even if 800 trout dinners are sold per year. What should be the price of the new item?

5. Spartan Castings must implement a manufacturing process that reduces the amount of particulates emitted into the atmosphere. Two processes have been identified that provide the same level of particulate reduction. The first process is expected to incur $350,000 of fixed cost and add $50 of variable cost to each casting Spartan produces. The second process has fixed costs of $150,000 and adds $90 of variable cost per casting.

a. What is the break-even quantity beyond which the first process is more attractive?

b. What is the difference in total cost if the quantity produced is 10,000?

6. A news clipping service is considering modernization. Rather than manually clipping and photocopying articles of interest and mailing them to its clients, employees electronically input stories from most widely circulated publications into a database. Each new issue is searched for key words, such as a client's company name, competitors' names, type of business, and the company's products, services, and officers. When matches occur, affected clients are instantly notified via an on-line network. If the story is of interest, it is electronically transmitted, so the client often has the story and can prepare comments for follow-up interviews before the publication hits the street. The manual process has fixed costs of $400,000 per year and variable costs of $6.20 per clipping mailed. The price charged the client is $8.00 per clipping. The computerized process has fixed costs of $1,300,000 per year and variable costs of $2.25 per story electronically transmitted to the client.

a. If the same price is charged for either process, what is the annual volume beyond which the automated process is more attractive?

b. The present volume of business is 225,000 clippings per year. Many of the clippings sent with the current process are not of interest to the client or are multiple copies of the same story appearing in several publications. The news clipping service believes that by improving service and by lowering the price to $4.00 per story, modernization will increase volume to 900,000 stories transmitted per year. Should the clipping service modernize?

c. If the forecasted increase in business is too optimistic, at what volume will the new process (with the $4.00 price) break even?

7. Hahn Manufacturing purchases a key component of one of its products from a local supplier. The current purchase price is $1,500 per unit. Efforts to standardize parts succeeded to the point that this same component can now be used in five different products. Annual component usage should increase from 150 to 750 units. Management wonders whether it is time to make the component in-house, rather than to continue buying it from the supplier. Fixed costs would increase by about $40,000 per year for the new equipment and tooling needed. The cost of raw materials and variable overhead would be about $1,100 per unit, and labor costs would be $300 per unit produced.

a. Should Hahn make rather than buy?

b. What is the break-even quantity?

c. What other considerations might be important?

8. Techno Corporation is currently manufacturing an item at variable costs of $5 per unit. Annual fixed costs of manufacturing this item are $140,000. The current selling price of the item is $10 per unit, and the annual sales volume is 30,000 units.

a. Techno can substantially improve the item's quality by installing new equipment at additional annual fixed costs of $60,000. Variable costs per unit would increase by $1, but, as more of the better-quality product could be sold, the annual volume would increase to 50,000 units. Should Techno buy the new equipment and maintain the current price of the item? Why or why not?

b. Alternatively, Techno could increase the selling price to $11 per unit. However, the annual sales volume would be limited to 45,000 units. Should Techno buy the new equipment and raise the price of the item? Why or why not?

9. The Tri-County Generation and Transmission Association is a nonprofit cooperative organization that provides electrical service to rural customers. Based on a faulty long-range demand forecast, Tri-County overbuilt its generation and distribution system. Tri-County now has much more capacity than it needs to serve its customers. Fixed costs, mostly debt service on investment in plant and equipment, are $82.5 million per year. Variable costs, mostly fossil fuel costs, are $25 per megawatt-hour (MWh, or million watts of power used for one hour). The new person in charge of

demand forecasting prepared a short-range forecast for use in next year's budgeting process. That forecast calls for Tri-County customers to consume 1 million MWh of energy next year.

a. How much will Tri-County need to charge its customers per MWh to break even next year?

b. The Tri-County customers balk at that price and conserve electrical energy. Only 95 percent of forecasted demand materializes. What is the resulting surplus or loss for this nonprofit organization?

10. Earthquake, drought, fire, economic famine, flood, and a pestilence of TV court reporters have caused an exodus from the City of Angels to Boulder, Colorado. The sudden increase in demand is straining the capacity of Boulder's electrical system. Boulder's alternatives have been reduced to buying 150,000 MWh of electric power from Tri-County G&T at a price of $75 per MWh, or refurbishing and recommissioning the abandoned Pearl Street Power Station in downtown Boulder. Fixed costs of that project are $10 million per year, and variable costs would be $35 per MWh. Should Boulder build or buy?

11. Tri-County G&T sells 150,000 MWh per year of electrical power to Boulder at $75 per MWh, has fixed costs of $82.5 million per year, and has variable costs of $25 per MWh. If Tri-County has 1,000,000 MWh of demand from its customers (other than Boulder), what will Tri-County have to charge to break even?

PREFERENCE MATRIX

12. The Forsite Company is screening three ideas for new services. Resource constraints allow only one idea to be commercialized at the present time. The following estimates have been made for the five performance criteria that management believes to be most important:

Performance Criterion	RATING		
	Service A	Service B	Service C
Capital equipment investment required	0.6	0.8	0.3
Expected return on investment (ROI)	0.7	0.3	0.9
Compatibility with current workforce skills	0.4	0.7	0.5
Competitive advantage	1.0	0.4	0.6
Compatibility with EPA requirements	0.2	1.0	0.5

a. Calculate a total weighted score for each alternative. Use a preference matrix and assume equal weights for each performance criterion. Which alternative is best? Worst?

b. Suppose that the expected ROI is given twice the weight assigned to each of the remaining criteria. (The sum of weights should remain the same as in part (a).) Does this modification affect the ranking of the three potential services?

13. You are in charge of analyzing five new suppliers of an important raw material and have been given the information shown below (1 = worst, 10 = best). Management has decided that criteria 2 and 3 are equally important and that criteria 1 and 4 are each four times as important as criterion 2. No more than 2 new suppliers are required but each new vendor must exceed a total score of 70 percent of the maximum total points to be considered.

Performance Criterion	RATING				
	Vendor A	Vendor B	Vendor C	Vendor D	Vendor E
Quality of raw material	8	7	3	6	9
Environmental impact	3	8	4	7	7
Responsiveness to order changes	9	5	7	6	5
Cost of raw material	7	6	9	2	7

a. Which new vendors do you recommend?

b. Would your decision change if the criteria were considered equally important?

14. Accel Express, Inc., collected the following information on where to locate a warehouse (1 = poor, 10 = excellent):

Location Factor	Factor Weight	LOCATION SCORE	
		A	B
Construction costs	10	8	5
Utilities available	10	7	7
Business services	10	4	7
Real estate cost	20	7	4
Quality of life	20	4	8
Transportation	30	7	6

a. Which location, A or B, should be chosen on the basis of the total weighted score?

b. If the factors were weighted equally, would the choice change?

DECISION THEORY AND DECISION TREE

15. Build-Rite Construction has received favorable publicity from guest appearances on a public TV home improvement program. Public TV programming decisions seem to be unpredictable, so Build-Rite cannot estimate the probability of continued benefits from its relationship with the show. Demand for home improvements next year may be either low or high. But Build-Rite must decide now whether to hire more employees, do nothing, or develop

subcontracts with other home improvement contractors. Build-Rite has developed the following payoff table:

Alternative	DEMAND FOR HOME IMPROVEMENTS		
	Low	Moderate	High
Hire	($250,000)	$100,000	$625,000
Subcontract	$100,000	$150,000	$415,000
Do nothing	$50,000	$80,000	$300,000

Which alternative is best, according to each of the following decision criteria?

a. Maximin

b. Maximax

c. Laplace

d. Minimax regret

16. Analyze the decision tree in the following figure. What is the expected payoff for the best alternative? First, be sure to infer the missing probabilities.
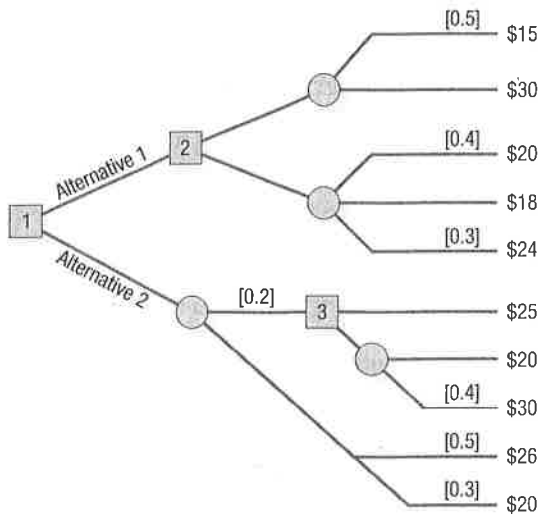
17. A manager is trying to decide whether to buy one machine or two. If only one is purchased and demand proves to be excessive, the second machine can be purchased later. Some sales will be lost, however, because the lead time for producing this type of machine is six months. In addition, the cost per machine will be lower if both are purchased at the same time. The probability of low demand is estimated to be 0.20. The after-tax net present value of the benefits from purchasing the two machines together is $90,000 if demand is low and $180,000 if demand is high.

If one machine is purchased and demand is low, the net present value is $120,000. If demand is high, the manager has three options. Doing nothing has a net present value of $120,000; subcontracting, $160,000; and buying the second machine, $140,000.

a. Draw a decision tree for this problem.

b. How many machines should the company buy initially? What is the expected payoff for this alternative?

18. A manager is trying to decide whether to build a small, medium, or large facility. Demand can be low, average, or high, with the estimated probabilities being 0.25, 0.40, and 0.35, respectively.

A small facility is expected to earn an after-tax net present value of just $18,000 if demand is low. If demand is average, the small facility is expected to earn $75,000; it can be increased to medium size to earn a net present value of $60,000. If demand is high, the small facility is expected to earn $75,000 and can be expanded to medium size to earn $60,000 or to large size to earn $125,000.

A medium-sized facility is expected to lose an estimated $25,000 if demand is low and earn $140,000 if demand is average. If demand is high, the medium-sized facility is expected to earn a net present value of $150,000; it can be expanded to a large size for a net payoff of $145,000.

If a large facility is built and demand is high, earnings are expected to be $220,000. If demand is average for the large facility, the present value is expected to be $125,000; if demand is low, the facility is expected to lose $60,000.

a. Draw a decision tree for this problem.

b. What should management do to achieve the highest expected payoff?

c. Which alternative is best, according to each of the following decision criterion?

Maximin

Maximax

Minimax regret

19. A manufacturing plant has reached full capacity. The company must build a second plant—either small or large—at a nearby location. The demand is likely to be high or low. The probability of low demand is 0.3. If demand is low, the large plant has a present value of $5 million and the small plant, a present value of $8 million. If demand is high, the large plant pays off with a present value of $18 million and the small plant with a present value of only $10 million. However, the small plant can be expanded later if demand proves to be high, for a present value of $14 million.

a. Draw a decision tree for this problem.

b. What should management do to achieve the highest expected payoff?

20. Benjamin Moses, chief engineer of Offshore Chemicals, Inc., must decide whether to build a new processing facility based on an experimental technology. If the new facility works, the company will realize a net profit of $20 million. If the new facility fails, the company will lose $10 million. Benjamin's best guess is that there is a 40 percent chance that the new facility will work.

What decision should Benjamin Moses make?

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Ragsdale, Cliff. *Spreadsheet Modeling & Decision Analysis: A Practical Introduction to Management Science,* 6th ed. Cincinnati, OH: South-Western, 2011.