Location Strategies

CHAPTER 8

CHAPTER OUTLINE

GLOBAL COMPANY PROFILE: *FedEx*

Alaska Airlines

Alaska Airlines

10 OM STRATEGY DECISIONS

- Design of Goods and Services
- Managing Quality
- Process Strategy
- *Location Strategies*
- Layout Strategies
- Human Resources
- Supply-Chain Management
- Inventory Management
- Scheduling
- Maintenance

GLOBAL COMPANY PROFILE
FedEx

Location Provides Competitive Advantage for FedEx

Overnight-delivery powerhouse FedEx has believed in the hub concept for its 46-year existence. Even though Fred Smith, founder and CEO, got a C on his college paper proposing a hub for small-package delivery, the idea has proven extremely successful. Starting with one central location in Memphis, Tennessee (now called its *superhub*), the $45 billion firm has added a European hub in Paris, an Asian hub in Guangzhou, China, a Latin American hub in Miami, and a Canadian hub in Toronto. FedEx's fleet of 667 planes flies into 375 airports worldwide, then delivers to the door with more than 80,000 vans and trucks.

At the FedEx hub in Memphis, Tennessee, approximately 100 FedEx aircraft converge each night around midnight with more than 5 million documents and packages.

Oliver Berg/EPA/Newscom

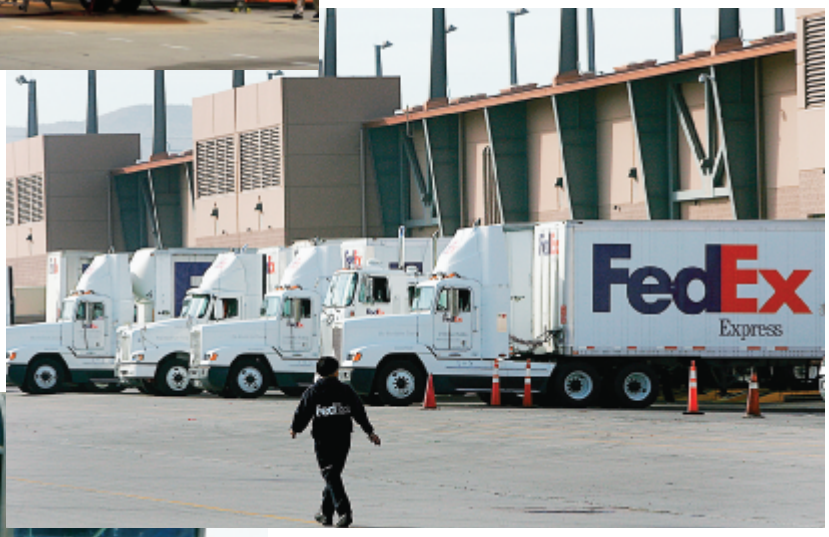
At the preliminary sorting area, packages and documents are sorted and sent to a secondary sorting area. The Memphis facility covers 1.5 million square feet; it is big enough to hold 33 football fields. Packages are sorted and exchanged until 4 A.M.

Troy Glasgow/AP Images

Lance Murphey/Reuters/Newscom

Packages and documents that have already gone through the primary and secondary sorts are checked by city, state, and zip code. They are then placed in containers that are loaded onto aircraft for delivery to their final destinations in 236 countries.

FedEx's fleet of 667 planes makes it the largest airline in the world. More than 80,000 trucks complete the delivery process.



Matt York/AP Images

Shi Li/shzq/ImagineChina

The $150 million hub opened in Guangzhou in 2009 lies in the heart of one of China's fastest-growing manufacturing districts. FedEx controls 39% of the China-to-U.S. air express market.

Why was Memphis picked as FedEx's central location? (1) It is located in the middle of the U.S. (2) It has very few hours of bad weather closures, perhaps contributing to the firm's excellent flight-safety record. (3) It provided FedEx with generous tax incentives.

Each night, except Sunday, FedEx brings to Memphis packages from throughout the world that are going to cities for which FedEx does not have direct flights. The central hub permits service to a far greater number of points with fewer aircraft than the traditional City-A-to-City-B system. It also allows FedEx to match aircraft flights with package loads each night and to reroute flights when load volume requires it, a major cost savings. Moreover, FedEx also believes that the central hub system helps reduce mishandling and delay in transit because there is total control over the packages from pickup point through delivery.

LEARNING OBJECTIVES

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The Strategic Importance of Location

VIDEO 8.1
Hard Rock's Location Selection

World markets continue to expand, and the global nature of business is accelerating. Indeed, one of the most important strategic decisions made by many companies, including FedEx, Mercedes-Benz, and Hard Rock, is where to locate their operations. When FedEx opened its Asian hub in Guangzhou, China, it set the stage for "round-the-world" flights linking its Paris and Memphis package hubs to Asia. When Mercedes-Benz announced its plans to build its first major overseas plant in Vance, Alabama, it completed a year of competition among 170 sites in 30 states and two countries. When Hard Rock Cafe opened in Moscow, it ended 3 years of advance preparation of a Russian food-supply chain. The strategic impact, cost, and international aspect of these decisions indicate how significant location decisions are.

Firms throughout the world are using the concepts and techniques of this chapter to address the location decision because location greatly affects both fixed and variable costs. Location has a major impact on the overall risk and profit of the company. For instance, depending on the product and type of production or service taking place, transportation costs alone can total as much as 25% of the product's selling price. That is, one-fourth of a firm's total revenue may be needed just to cover freight expenses of the raw materials coming in and finished products going out. Other costs that may be influenced by location include taxes, wages, raw material costs, and rents. When all costs are considered, location may alter total operating expenses as much as 50%.

The economics of transportation are so significant that companies—and even cities—have coalesced around a transportation advantage. For centuries, rivers and ports, and more recently rail hubs and then interstate highways, were a major ingredient in the location decision. Today airports are often the deciding factor, providing fast, low-cost transportation of goods and people.

Companies make location decisions relatively infrequently, usually because demand has outgrown the current plant's capacity or because of changes in labor productivity, exchange rates, costs, or local attitudes. Companies may also relocate their manufacturing or service facilities because of shifts in demographics and customer demand.

Location options include (1) expanding an existing facility instead of moving, (2) maintaining current sites while adding another facility elsewhere, or (3) closing the existing facility and moving to another location.

The location decision often depends on the type of business. For industrial location decisions, the strategy is usually minimizing costs, although locations that foster innovation and creativity may also be critical. For retail and professional service organizations, the strategy focuses on maximizing revenue. Warehouse location strategy, however, may be driven by a combination of cost and speed of delivery. *The objective of location strategy is to maximize the benefit of location to the firm.*

Location and Costs Because location is such a significant cost and revenue driver, location often has the power to make (or break) a company's business strategy. Key multinationals in every major industry, from automobiles to cellular phones, now have or are planning a presence in each of their major markets. Location decisions to support a low-cost strategy require particularly careful consideration.

Once management is committed to a specific location, many costs are firmly in place and difficult to reduce. For instance, if a new factory location is in a region with high energy costs, even good management with an outstanding energy strategy is starting at a disadvantage. Management is in a similar bind with its human resource strategy if labor in the selected location is expensive, ill-trained, or has a poor work ethic. Consequently, hard work to determine an optimal facility location is a good investment.

Factors That Affect Location Decisions

Selecting a facility location is becoming much more complex with globalization. As we saw in Chapter 2, globalization has taken place because of the development of (1) market economics; (2) better international communications; (3) more rapid, reliable travel and shipping; (4) ease of capital flow between countries; and (5) high differences in labor costs. Many firms now consider opening new offices, factories, retail stores, or banks outside their home country. Location decisions transcend national borders. In fact, as Figure 8.1 shows, the sequence of location decisions often begins with choosing a country in which to operate.

One approach to selecting a country is to identify what the parent organization believes are key success factors (KSFs) needed to achieve competitive advantage. Six possible country KSFs are listed at the top of Figure 8.1. Using such factors (including some negative ones, such as crime) the World Economic Forum biannually ranks the global competitiveness of 144 countries (see Table 8.1). Switzerland placed first because of its high rates of saving and investment, openness to trade, quality education, and efficient government.

Once a firm decides which country is best for its location, it focuses on a region of the chosen country and a community. The final step in the location decision process is choosing a specific site within a community. The company must pick the one location that is best suited for shipping and receiving, zoning, utilities, size, and cost. Again, Figure 8.1 summarizes this series of decisions and the factors that affect them.

TABLE 8.1

Competitiveness of 144 Selected Countries, Based on Annual Surveys of 13,000 Business Executives

COUNTRY	2015 RANKING
Switzerland	1
Singapore	2
U.S.	3
Finland	4
Germany	5
Japan	6
⋮	
Canada	15
⋮	
Israel	27
China	28
⋮	
Russia	53
⋮	
Mexico	61
⋮	
Vietnam	68
⋮	
Haiti	137
⋮	
Chad	143
Guinea	144

Source: www.weforum.org, 2015. Used with permission of World Economic Forum.

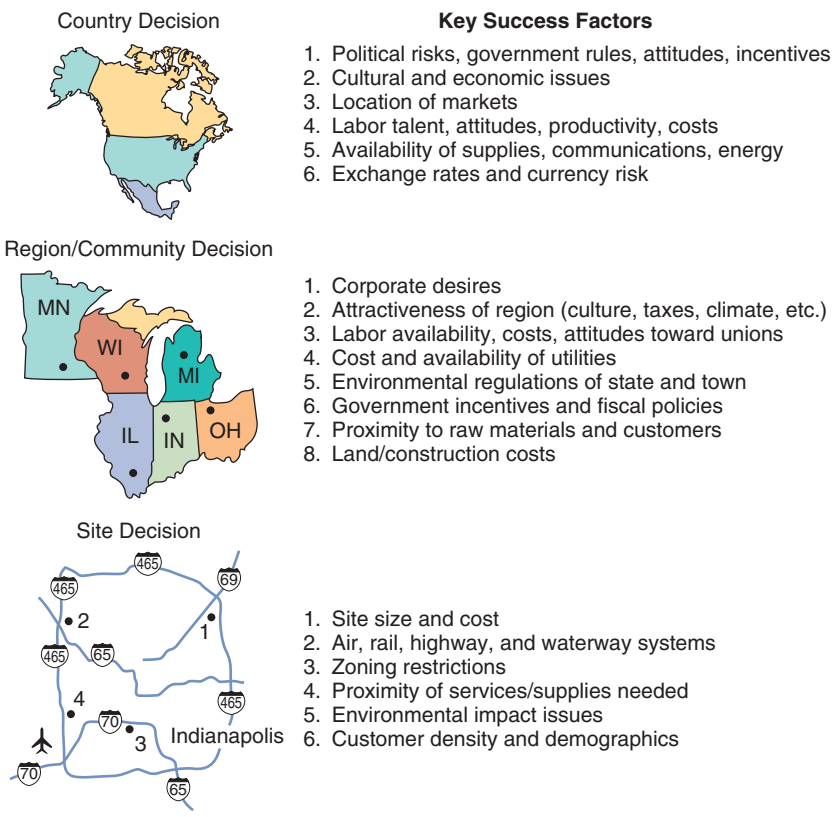


Figure **8.1**

Some Considerations and Factors That Affect Location Decisions

LO 8.1 *Identify* and explain seven major factors that affect location decisions

Besides globalization, a number of other factors affect the location decision. Among these are labor productivity, foreign exchange, culture, changing attitudes toward the industry, and proximity to markets, suppliers, and competitors.

Labor Productivity

LO 8.2 *Compute* labor productivity

When deciding on a location, management may be tempted by an area's low wage rates. However, wage rates cannot be considered by themselves, as Otis Elevator discovered when it opened its plant in Mexico in 1998. But by 2011, Otis found a move to an automated plant in South Carolina more advantageous. Management must also consider productivity.

As discussed in Chapter 1, differences exist in productivity in various countries. What management is really interested in is the combination of production and the wage rate. For example, if Otis Elevator pays $70 per day with 60 units produced per day in South Carolina, it will spend less on labor than at a Mexican plant that pays $25 per day with production of 20 units per day:

$$\frac{\text{Labor cost per day}}{\text{Production (units per day)}} = \text{Labor cost per unit}$$

1. Case 1: South Carolina plant:

$$\frac{\$70 \text{ Wages per day}}{60 \text{ Units produced per day}} = \frac{\$70}{60} = \$1.17 \text{ per unit}$$

2. Case 2: Juarez, Mexico, plant:

$$\frac{\$25 \text{ Wages per day}}{20 \text{ Units produced per day}} = \frac{\$25}{20} = \$1.25 \text{ per unit}$$

STUDENT TIP Final cost is the critical factor, and low productivity can negate low wages.

Employees with poor training, poor education, or poor work habits may not be a good buy even at low wages. By the same token, employees who cannot or will not always reach their places of work are not much good to the organization, even at low wages. (Labor cost per unit is sometimes called the *labor content* of the product.)

Exchange Rates and Currency Risk

Although wage rates and productivity may make a country seem economical, unfavorable exchange rates may negate any savings. Sometimes, though, firms can take advantage of a particularly favorable exchange rate by relocating or exporting to a foreign country. However, the values of foreign currencies continually rise and fall in most countries. Such changes could well make what was a good location in 2015 a disastrous one in 2019. *Operational hedging* describes the situation where firms have excess capacity in multiple countries and then shift production levels from location to location as exchange rates change.

Costs

Tangible costs
Readily identifiable costs that can be measured with some precision.

We can divide location costs into two categories, tangible and intangible. **Tangible costs** are those costs that are readily identifiable and precisely measured. They include utilities, labor, material, taxes, depreciation, and other costs that the accounting department and management can identify. In addition, such costs as transportation of raw materials, transportation of finished goods, and site construction are all factored into the overall cost of a location. Government incentives, as we see in the *OM in Action* box "Luxembourg, a Country who Saved Companies Billions," also affect a location's cost.

Intangible costs
A category of location costs that cannot be easily quantified, such as quality of life and government.

Intangible costs are less easily quantified. They include quality of education, public transportation facilities, community attitudes toward the industry and the company, and quality and attitude of prospective employees. They also include quality-of-life variables, such as climate and sports teams, that may influence personnel recruiting.

OM in Action Luxembourg, a country who saved companies billions

Situated at the geographical and political heart of Europe, Luxembourg has become a major international financial centre over the years and is now the largest hub for investment funds in the EU. It has not been hit hard by the financial crisis, with the government maintaining incentives such as a low VAT rate, political stability and swift updates to legislation.

The main factors that attract foreign investors havenot changed much over the past few years. Luxembourg has a stable political system and a strong economy that enables it to maintain and even reinforce the attractiveness of its tax regime for foreign investors. It also has an important financial centre, making it convenient for the funds industry and financing transactions. Another factor is that Luxembourg is highly international, both politically and economically, with an educated, multicultural and multilingual workforce. Overall, more than 40,000 companies are registered in the country (with household names like PepsiCo PEP and Heinz).

The banking and financial sector keeps leading the country's economy. With over 147 banks from 27 countries, and over 42,000 employees, Luxembourg is a key financial centre for all European investment funds, private banking activities, banks, life insurance and reinsurance companies. It's also getting to be known as a centre of international law firms. The first wave coming into the country was the top law firms such as Clifford Chance and Allen &Overy, along with US firms such as Dechert and Bakers. Now there's a wave of second-tier law firms joining the top players in Luxembourg, although there are doubts whether they are bringing added value or trying to get a share of the cake.There are also concerns about foreign firms posing problems for locals when it comes to recruiting skilled, educated manpower.They actually make the market more competitive. In some cases, there have been the whole team moving from an existing firm to join or found the Luxembourg office of a foreign firm.


gdbrekke/Fotolia

Moreover, these days the country is experiencing new challenges. Luxembourg is accused for facilitating tax arrangements or what is called sometimes as tax escape. US and some European politicians believe that a considerable number of large corporations use their legal expertise, and choose countries like Luxembourg to transfer parts of their business to. This helps them to save billions in their taxes. The EU has been trying to not provide such opportunities for those companies. G-20 countries came up with an idea of integrated tax rulings in 2014, which pushed Luxemburg to share its tax governance system. The tax regulation has become even tougher in early 2015, when the companies were obliged to pay the sales tax in any country in which they sell the product, whether physically or digitally. This was another shock for the e-commerce companies which were located in Luxemburg but selling products all around the world.

Sources: lockerroom.johnlocke.org (November 24, 2015), Fortune.com (November 27, 2015).

Political Risk, Values, and Culture

The political risk associated with national, state, and local governments' attitudes toward private and intellectual property, zoning, pollution, and employment stability may be in flux. Governmental positions at the time a location decision is made may not be lasting ones. However, management may find that these attitudes can be influenced by their own leadership.

Worker values may also differ from country to country, region to region, and small town to city. Worker views regarding turnover, unions, and absenteeism are all relevant factors. In turn, these values can affect a company's decision whether to make offers to current workers if the firm relocates to a new location. The case study at the end of this chapter, "Southern Recreational Vehicle Company," describes a St. Louis firm that actively chose *not to relocate* any of its workers when it moved to Mississippi.

One of the greatest challenges in a global operations decision is dealing with another country's culture. Cultural variations in punctuality by employees and suppliers make a marked difference in production and delivery schedules. Bribery and other forms of corruption also create substantial economic inefficiency, as well as ethical and legal problems in the global arena. As a result, operations managers face significant challenges when building effective supply chains across cultures. Table 8.2 provides one ranking of corruption in countries around the world.

TABLE 8.2

Ranking Corruption in Selected Countries (Score of 100 Represents a Corruption-Free Country

RANK	SCORE
1 Denmark	92
2 New Zealand	91
3 Finland	89
⋮	
10 Canada	81
⋮	
17 U.S., Hong Kong	74 (tie)
⋮	
37 Israel	60
⋮	
69 Brazil, Greece	43 (tie)
⋮	
136 Russia	27
⋮	
161 Haiti	19
⋮	
174 Somalia, North Korea	8 (tie)

Source: Transparency International's 2014 survey, at **www.transparency.org**. Used with permission of Transparency International.

Proximity to Markets

For many firms, locating near customers is extremely important. Particularly, service organizations, like drugstores, restaurants, post offices, or barbers, find that demographics and proximity to market are *the* primary location factors. Manufacturing firms find it useful to be close to customers when transporting finished goods is expensive or difficult (perhaps because they are bulky, heavy, or fragile). To be near U.S. markets, foreign-owned auto giants such as Mercedes, Honda, Toyota, and Hyundai are building millions of cars each year in the U.S.

In addition, with just-in-time production, suppliers want to locate near users. For a firm like Coca-Cola, whose product's primary ingredient is water, it makes sense to have bottling plants in many cities rather than shipping heavy (and sometimes fragile glass) containers cross country.

Proximity to Suppliers

Firms locate near their raw materials and suppliers because of (1) perishability, (2) transportation costs, or (3) bulk. Bakeries, dairy plants, and frozen seafood processors deal with *perishable* raw materials, so they often locate close to suppliers. Companies dependent on inputs of heavy or bulky raw materials (such as steel producers using coal and iron ore) face expensive inbound *transportation costs*, so transportation costs become a major factor. And goods for which there is a *reduction in bulk* during production (e.g., trees to lumber) typically need facilities near the raw material.

Proximity to Competitors (Clustering)

Clustering
The location of competing companies near each other, often because of a critical mass of information, talent, venture capital, or natural resources.

Both manufacturing and service organizations also like to locate, somewhat surprisingly, near competitors. This tendency, called **clustering**, often occurs when a major resource is found in that region. Such resources include natural resources, information resources, venture capital resources, and talent resources. Table 8.3 presents nine examples of industries that exhibit clustering, and the reasons why.

Italy may be the true leader when it comes to clustering, however, with northern zones of that country holding world leadership in such specialties as ceramic tile (Modena), gold jewelry (Vicenza), machine tools (Busto Arsizio), cashmere and wool (Biella), designer eyeglasses (Belluma), and pasta machines (Parma). When it comes to clusters for innovations in slaughtering, however (see the *OM in Action* box), Denmark is the leader.

Methods of Evaluating Location Alternatives

Four major methods are used for solving location problems: the factor-rating method, locational cost–volume analysis, the center-of-gravity method, and the transportation model. This section describes these approaches.

TABLE 8.3 Clustering of Companies

INDUSTRY	LOCATIONS	REASON FOR CLUSTERING
Wine making	Napa Valley (U.S.), Bordeaux region (France)	Natural resources of land and climate
Software firms	Silicon Valley, Boston, Bangalore, Israel	Talent resources of bright graduates in scientific/technical areas, venture capitalists nearby
Clean energy	Colorado	Critical mass of talent and information, with 1,000 companies
Theme parks (e.g., Disney World, Universal Studios, and Sea World)	Orlando, Florida	A hot spot for entertainment, warm weather, tourists, and inexpensive labor
Electronics firms (e.g., Sony, IBM, HP, Motorola, and Panasonic)	Northern Mexico	NAFTA, duty-free export to U.S. (24% of all TVs are built here)
Computer hardware manufacturing	Singapore, Taiwan	High technological penetration rates and per capita GDP, skilled/educated workforce with large pool of engineers
Fast-food chains (e.g., Wendy's, McDonald's, Burger King, Pizza Hut)	Sites within 1 mile of one another	Stimulate food sales, high traffic flows
General aviation aircraft (e.g., Cessna, Learjet, Boeing, Raytheon)	Wichita, Kansas	Mass of aviation skills (60–70% of world's small planes/jets are built here)
Athletic footwear, outdoor wear	Portland, Oregon	300 companies, many spawned by Nike, deep talent pool and outdoor culture

OM in Action Denmark's Meat Cluster

Every day, 20,000 pigs are delivered to the Danish Crown company's slaughterhouse in central Denmark. The pigs trot into the stunning room, guided by workers armed with giant fly swats. The animals are hung upside down, divided in two, shaved, and scalded clean. A machine cuts them into pieces, which are then cooled, boned, and packed.

The slaughterhouse is enormous: 10 football fields long with 7 miles of conveyor belts. Its managers attend to the tiniest detail. The workers wear green rather than white because this puts the pigs in a better mood. The cutting machine photographs a carcass before adjusting its blades to the exact carcass contours. The company calibrates not only how to carve the flesh, but also where the various parts will fetch the highest prices.

Denmark is a tiny country, with 5.6 million people and wallet-draining labor costs. But it is an agricultural giant, home to 30 million pigs and numerous global brands. Farm products make up over 20% of its goods exports—and the value of these exports is expected to grow from $5.5 billion in 2001 to $31 billion by 2020.

How is this meat-processing cluster still thriving? It is because clustering can be applied to ancient industries like slaughtering as well as to new ones. The cluster includes several big companies: Danish Crown, Arla, Rose Poultry, and DuPont Danisco, as well as plenty of smaller firms, which act as indicators of nascent trends and incubators of new ideas. Other firms are contributing information technology tools for the cluster. Among these are LetFarm for fields, Bovisoft for stables, Agrosoft for pigs, Webstech for grain, and InOMEGA for food.

The cluster also has a collection of productivity-spurring institutions (the Cattle Research Center, for example, creates ways to boost pork productivity through robotics) and Danish Tech University, where 1,500 people work on food-related subjects.

Racorn/123rf

Sources: The Economist (Jan. 4, 2014); and *GlobalMeatNews.com* (Nov. 1, 2013).

The Factor-Rating Method

There are many factors, both qualitative and quantitative, to consider in choosing a location. Some of these factors are more important than others, so managers can use weightings to make the decision process more objective. The **factor-rating method** is popular because a wide variety of factors, from education to recreation to labor skills, can be objectively included. Figure 8.1 listed a few of the many factors that affect location decisions.

Factor-rating method
A location method that instills objectivity into the process of identifying hard-to-evaluate costs.

The factor-rating method (which we introduced in Chapter 2) has six steps:

1. Develop a list of relevant factors called *key success factors* (such as those in Figure 8.1).
2. Assign a weight to each factor to reflect its relative importance in the company's objectives.
3. Develop a scale for each factor (for example, 1 to 10 or 1 to 100 points).
4. Have management score each location for each factor, using the scale in Step 3.
5. Multiply the score by the weights for each factor and total the score for each location.
6. Make a recommendation based on the maximum point score, considering the results of other quantitative approaches as well.

Example 1

LO 8.3 *Apply* the factor-rating method

FACTOR-RATING METHOD FOR AN EXPANDING THEME PARK

Five Flags over Florida, a U.S. chain of 10 family-oriented theme parks, has decided to expand overseas by opening its first park in Europe. It wishes to select between France and Denmark.

APPROACH ► The ratings sheet in Table 8.4 lists key success factors that management has decided are important; their weightings and their rating for two possible sites—Dijon, France, and Copenhagen, Denmark—are shown.

STUDENT TIP
These weights do not need to be on a 0–1 scale or total to 1. We can use a 1–10 scale, 1–100 scale, or any other scale we prefer.

TABLE 8.4 Weights, Scores, and Solution

KEY SUCCESS FACTOR	WEIGHT	SCORES (OUT OF 100)		WEIGHTED SCORES	
		FRANCE	DENMARK	FRANCE	DENMARK
Labor availability and attitude	.25	70	60	(.25)(70) = 17.50	(.25)(60) = 15.00
People-to-car ratio	.05	50	60	(.05)(50) = 2.50	(.05)(60) = 3.00
Per capita income	.10	85	80	(.10)(85) = 8.50	(.10)(80) = 8.00
Tax structure	.39	75	70	(.39)(75) = 29.25	(.39)(70) = 27.30
Education and health	.21	60	70	(.21)(60) = 12.60	(.21)(70) = 14.70
Totals	1.00			70.35	68.00

SOLUTION ▶ Table 8.4 uses weights and scores to evaluate alternative site locations. Given the option of 100 points assigned to each factor, the French location is preferable.

INSIGHT ▶ By changing the points or weights slightly for those factors about which there is some doubt, we can analyze the sensitivity of the decision. For instance, we can see that changing the scores for "labor availability and attitude" by 10 points can change the decision. The numbers used in factor weighting can be subjective, and the model's results are not "exact" even though this is a quantitative approach.

LEARNING EXERCISE ▶ If the weight for "tax structure" drops to .20 and the weight for "education and health" increases to .40, what is the new result? [Answer: Denmark is now chosen, with a 68.0 vs. a 67.5 score for France.]

RELATED PROBLEMS ▶ 8.5–8.15, 8.24, 8.25 (8.26, 8.27, 8.28, 8.33, 8.34 are available in MyOMLab)

EXCEL OM Data File Ch08Ex1.xls can be found in MyOMLab.

When a decision is sensitive to minor changes, further analysis of the weighting and the points assigned may be appropriate. Alternatively, management may conclude that these intangible factors are not the proper criteria on which to base a location decision. Managers therefore place primary weight on the more quantitative aspects of the decision.

Locational Cost–Volume Analysis

Locational cost–volume analysis
A method of making an economic comparison of location alternatives.

Locational cost–volume analysis is a technique for making an economic comparison of location alternatives. By identifying fixed and variable costs and graphing them for each location, we can determine which one provides the lowest cost. Locational cost–volume analysis can be done mathematically or graphically. The graphic approach has the advantage of providing the range of volume over which each location is preferable.

The three steps to locational cost–volume analysis are as follows:

1. Determine the fixed and variable cost for each location.
2. Plot the costs for each location, with costs on the vertical axis of the graph and annual volume on the horizontal axis.
3. Select the location that has the lowest total cost for the expected production volume.

Example 2

LOCATIONAL COST–VOLUME ANALYSIS FOR A PARTS MANUFACTURER

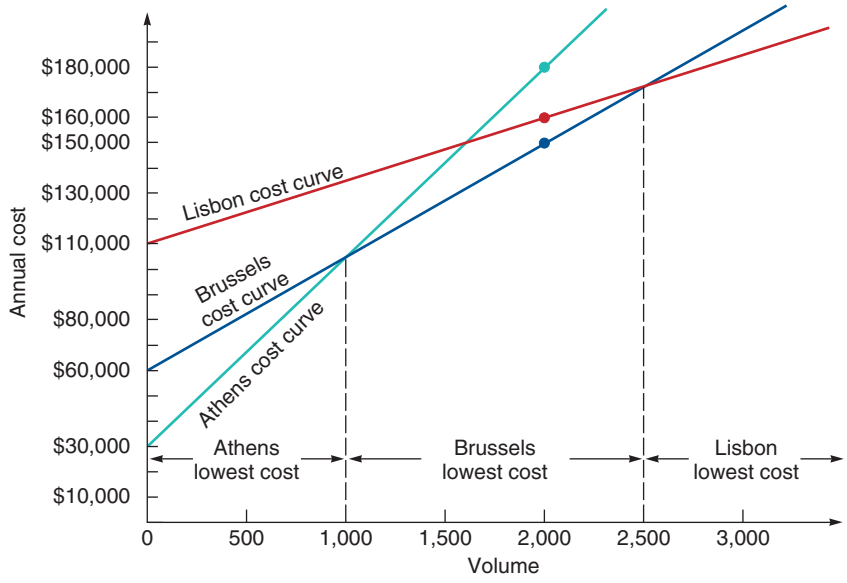
Esmail Mohebbi, owner of European Ignitions Manufacturing, needs to expand his capacity. He is considering three locations—Athens, Brussels, and Lisbon—for a new plant. The company wishes to find the most economical location for an expected volume of 2,000 units per year.

APPROACH ▶ Mohebbi conducts locational cost–volume analysis. To do so, he determines that fixed costs per year at the sites are $30,000, $60,000, and $110,000, respectively; and variable costs are $75 per unit, $45 per unit, and $25 per unit, respectively. The expected selling price of each ignition system produced is $120.

SOLUTION ▶ For each of the three locations, Mohebbi can plot the fixed costs (those at a volume of zero units) and the total cost (fixed costs + variable costs) at the expected volume of output. These lines have been plotted in Figure 8.2.

Figure **8.2**

Crossover Chart for Locational Cost–Volume Analysis



For Athens:

$$\text{Total cost} = \$30{,}000 + \$75(2{,}000) = \$180{,}000$$

For Brussels:

$$\text{Total cost} = \$60{,}000 + \$45(2{,}000) = \$150{,}000$$

For Lisbon:

$$\text{Total cost} = \$110{,}000 + \$25(2{,}000) = \$160{,}000$$

LO 8.4 *Complete* a locational cost–volume analysis graphically and mathematically

With an expected volume of 2,000 units per year, Brussels provides the lowest cost location. The expected profit is:

$$\text{Total revenue} - \text{Total cost} = \$120(2{,}000) - \$150{,}000 = \$90{,}000 \text{ per year}$$

The crossover point for Athens and Brussels is:

$$\begin{aligned} 30{,}000 + 75(x) &= 60{,}000 + 45(x) \\ 30(x) &= 30{,}000 \\ x &= 1{,}000 \end{aligned}$$

and the crossover point for Brussels and Lisbon is:

$$\begin{aligned} 60{,}000 + 45(x) &= 110{,}000 + 25(x) \\ 20(x) &= 50{,}000 \\ x &= 2{,}500 \end{aligned}$$

INSIGHT ▶ As with every other OM model, locational cost–volume analysis can be sensitive to input data. For example, for a volume of less than 1,000, Athens would be preferred. For a volume greater than 2,500, Lisbon would yield the greatest profit.

LEARNING EXERCISE ▶ The variable cost for Lisbon is now expected to be $22 per unit. What is the new crossover point between Brussels and Lisbon? [Answer: 2,174 units.]

RELATED PROBLEMS ▶ 8.16–8.19 (8.29, 8.30 are available in MyOMLab)

EXCEL OM Data File **Ch08Ex2.xls** can be found in MyOMLab.

Center-of-Gravity Method

Center-of-gravity method
A mathematical technique used for finding the best location for a single distribution point that services several stores or areas.

The **center-of-gravity method** is a mathematical technique used for finding the location of a distribution center that will minimize distribution costs. The method takes into account the location of markets, the volume of goods shipped to those markets, and shipping costs in finding the best location for a distribution center.

The first step in the center-of-gravity method is to place the locations on a coordinate system. This will be illustrated in Example 3. The origin of the coordinate system and the scale used are arbitrary, just as long as the relative distances are correctly represented. This can be done easily by placing a grid over an ordinary map. The center of gravity is determined using Equations (8-1) and (8-2):

$$x\text{-coordinate of the center of gravity} = \frac{\sum_i x_i Q_i}{\sum_i Q_i} \tag{8-1}$$

$$y\text{-coordinate of the center of gravity} = \frac{\sum_i y_i Q_i}{\sum_i Q_i} \tag{8-2}$$

LO 8.5 *Use* the center-of-gravity method

where x_i = x-coordinate of location i
y_i = y-coordinate of location i
Q_i = Quantity of goods moved to or from location i

Note that Equations (8-1) and (8-2) include the term Q_i, the quantity of supplies transferred to or from location i.

Because the number of containers shipped each month affects cost, distance alone should not be the principal criterion. The center-of-gravity method assumes that cost is directly proportional to both distance and volume shipped. The ideal location is that which minimizes the weighted distance between sources and destinations, where the distance is weighted by the number of containers shipped.[1]

Example 3

CENTER OF GRAVITY

Quain's Discount Department Stores, a chain of four large Target-type outlets, has store locations in Chicago, Pittsburgh, New York, and Atlanta; they are currently being supplied out of an old and inadequate warehouse in Pittsburgh, the site of the chain's first store. The firm wants to find some "central" location in which to build a new warehouse.

APPROACH ▶ Quain's will apply the center-of-gravity method. It gathers data on demand rates at each outlet (see Table 8.5).

TABLE 8.5 Demand for Quain's Discount Department Stores

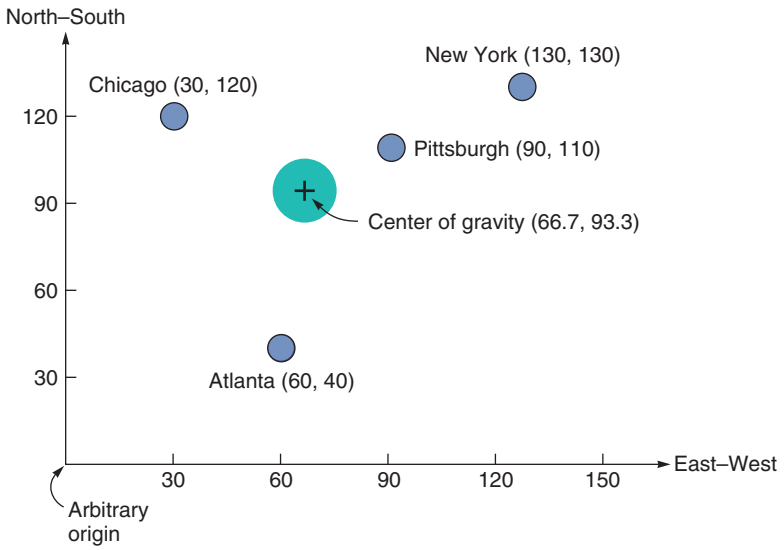
STORE LOCATION	NUMBER OF CONTAINERS SHIPPED PER MONTH
Chicago	2,000
Pittsburgh	1,000
New York	1,000
Atlanta	2,000

Its current store locations are shown in Figure 8.3. For example, location 1 is Chicago, and from Table 8.5 and Figure 8.3, we have:

$$x_1 = 30$$
$$y_1 = 120$$
$$Q_1 = 2{,}000$$

Figure 8.3

Coordinate Locations of Four Quain's Department Stores and Center of Gravity



SOLUTION ▶ Using the data in Table 8.5 and Figure 8.3 for each of the other cities, and Equations (8-1) and (8-2), we find:

x-coordinate of the center of gravity:

$$= \frac{(30)(2000) + (90)(1000) + (130)(1000) + (60)(2000)}{2000 + 1000 + 1000 + 2000} = \frac{400{,}000}{6{,}000}$$

$$= 66.7$$

y-coordinate of the center of gravity:

$$= \frac{(120)(2000) + (110)(1000) + (130)(1000) + (40)(2000)}{2000 + 1000 + 1000 + 2000} = \frac{560{,}000}{6{,}000}$$

$$= 93.3$$

This location (66.7, 93.3) is shown by the crosshairs in Figure 8.3.

INSIGHT ▶ By overlaying a U.S. map on Figure 8.3, we find this location (66.7, 93.3) is near central Ohio. The firm may well wish to consider Columbus, Ohio, or a nearby city as an appropriate location. But it is important to have both north–south and east–west interstate highways near the city selected to make delivery times quicker.

LEARNING EXERCISE ▶ The number of containers shipped per month to Atlanta is expected to grow quickly to 3,000. How does this change the center of gravity, and where should the new warehouse be located? [Answer: (65.7, 85.7), which is closer to Cincinnati, Ohio.]

RELATED PROBLEMS ▶ 8.20–8.23 (8.31, 8.32 are available in MyOMLab)

EXCEL OM Data File **Ch08Ex3.xls** can be found in MyOMLab.

ACTIVE MODEL 8.1 This example is further illustrated in Active Model 8.1 in MyOMLab.

Transportation Model

The objective of the **transportation model** is to determine the best pattern of shipments from several points of supply (sources) to several points of demand (destinations) so as to minimize total production and transportation costs. Every firm with a network of supply-and-demand points faces such a problem. The complex Volkswagen supply network (shown in Figure 8.4) provides one such illustration. We note in Figure 8.4, for example, that VW of Mexico ships vehicles for assembly and parts to VW of Nigeria, sends assemblies to VW of Brasil, and receives parts and assemblies from headquarters in Germany.

Transportation model
A technique for solving a class of linear programming problems.

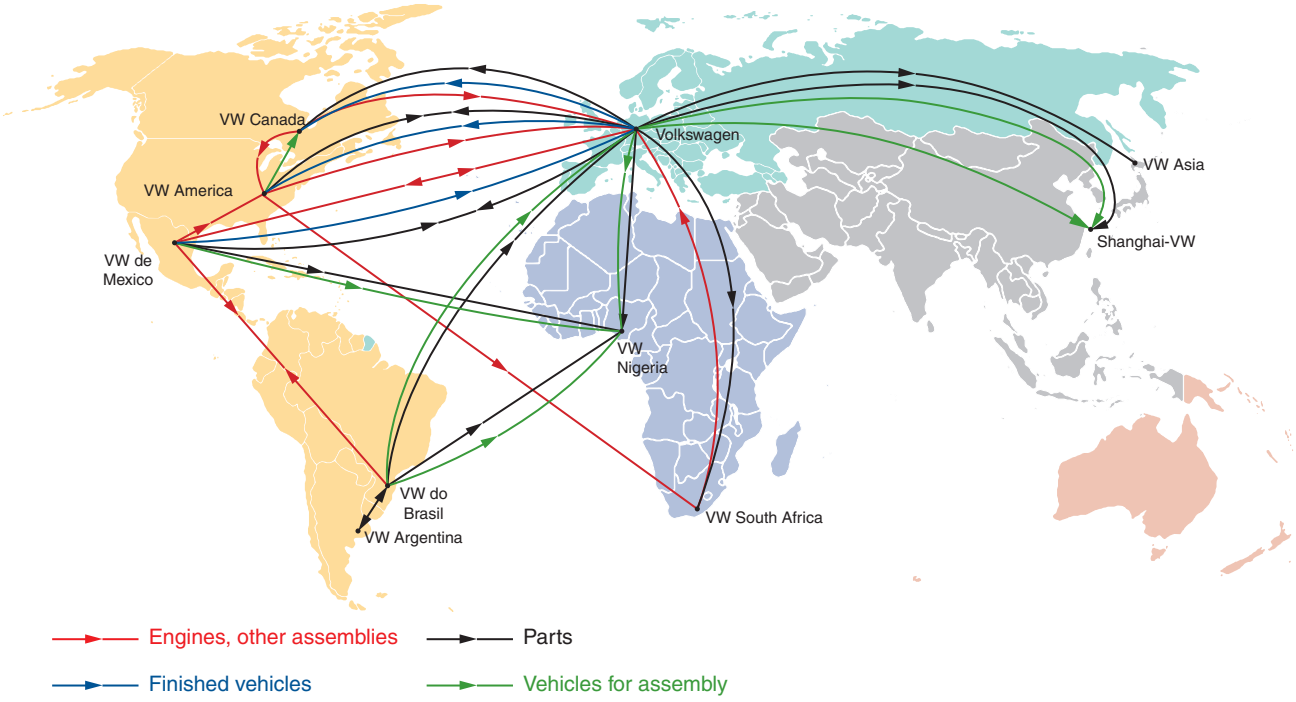


Figure 8.4

Volkswagen, the Third Largest Automaker in the World, Finds It Advantageous to Locate Its Plants Throughout the World

This graphic shows a portion of VW's supply network. There are 61 plants in Europe, along with nine countries in the Americas, Asia, and Africa.

Although the linear programming (LP) technique can be used to solve this type of problem, more efficient, special-purpose algorithms have been developed for the transportation application. The transportation model finds an initial feasible solution and then makes step-by-step improvement until an optimal solution is reached.

Service Location Strategy

While the focus in industrial-sector location analysis is on *minimizing cost,* the focus in the service sector is on *maximizing revenue.* This is because manufacturing firms find that costs tend to vary substantially among locations, while service firms find that location often has more impact on revenue than cost. Therefore, the location focus for service firms should be on determining the volume of customers and revenue.

STUDENT TIP Retail stores often attract more shoppers when competitors are close.

There are eight major determinants of volume and revenue for the service firm:

1. Purchasing power of the customer-drawing area
2. Service and image compatibility with demographics of the customer-drawing area
3. Competition in the area
4. Quality of the competition
5. Uniqueness of the firm's and competitors' locations
6. Physical qualities of facilities and neighboring businesses
7. Operating policies of the firm
8. Quality of management

Realistic analysis of these factors can provide a reasonable picture of the revenue expected. The techniques used in the service sector include regression analysis (see the *OM in Action* box, "Exhibition Centres Location"), traffic counts, demographic analysis, purchasing power analysis, the factor-rating method, the center-of-gravity method, and geographic information systems. Table 8.6 provides a summary of location strategies for both service and goods-producing organizations.

OM in Action Exhibition centres location

The importance of the exhibition industry increases with the development of technology and the globalisation of exhibitions. In addition, it is also a high-value service industry which considerably motivates international trades, and affects the associated industries, such as construction, tourism, transportation, marketing, and printing.

South Korea's close trade and economic ties to its neighbouring countries such as China, Japan, and Singapore, has made the exhibition and convention industry one of the country's major strategic industries. Exhibition centres play an important role as a basic infrastructure of the exhibition industry, and they are keys to the success of exhibitions and conventions.

The size of the exhibition centre and the location of the centres are closely related to the success of the exhibition. The location decisions in this industry are largely supported by operations management techniques such as factor rating method. The current and future demand for different candidate locations are usually forecasted based on a number of factors such as trade volume, GDP, the operation ratio of the exhibition centres, and gross regional domestic product(GRDP), the characteristics of the exhibitions, the exhibition infrastructure, the intention of local governments, and the policy considerations.

Mike Booth/Alamy

In a particular focus study, the South Korean Ministry of Trade, Industry and Energy identified 65 variables for the exhibition location decisions, based on expert opinion. To facilitate the decision making process based on the factor rating method, the variables were allocated to six major factors: neighbouring exhibition centres, local infrastructures, potential exhibition participants, local exhibition industry, local economy, and local government's network.

The well-defined and validated location decision factors ensure collaborative and cooperative participation of different stakeholders in the exhibition industry, and enhance the operations and outputs of the exhibition centres.

Sources: Park, S., Kim, B. S., Su, D., & Jiang, Z. A Study of the Determinants of Location Choice for Exhibition Centers.Proceedings of 5th Asia-Pacific Business Research Conference, 17 - 18 February, 2014, Kuala Lumpur, Malaysia, ISBN: 978-1-922069-44-3.

TABLE 8.6 Location Strategies—Service vs. Goods-Producing Organizations

SERVICE/RETAIL/PROFESSIONAL	*GOODS-PRODUCING*
REVENUE FOCUS	**COST FOCUS**
Volume/revenue Drawing area; purchasing power Competition; advertising/pricing **Physical quality** Parking/access; security/lighting; appearance/image **Cost determinants** Rent Management caliber Operation policies (hours, wage rates)	**Tangible costs** Transportation cost of raw material Shipment cost of finished goods Energy and utility cost; labor; raw material; taxes, and so on **Intangible and future costs** Attitude toward union Quality of life Education expenditures by state Quality of state and local government
TECHNIQUES	**TECHNIQUES**
Regression models to determine importance of various factors Factor-rating method Traffic counts Demographic analysis of drawing area Purchasing power analysis of area Center-of-gravity method Geographic information systems	Transportation method Factor-rating method Locational cost–volume analysis Crossover charts
ASSUMPTIONS	**ASSUMPTIONS**
Location is a major determinant of revenue High customer-interaction issues are critical Costs are relatively constant for a given area; therefore, the revenue function is critical	Location is a major determinant of cost Most major costs can be identified explicitly for each site Low customer contact allows focus on the identifiable costs Intangible costs can be evaluated

STUDENT TIP
This table helps differentiate between service- and manufacturing-sector decisions.

LO 8.6 *Understand* the differences between service- and industrial-sector location analysis

Geographic Information Systems

Geographic information systems are an important tool to help firms make successful, analytical decisions with regard to location. A **geographic information system (GIS)** stores, accesses, displays, and links demographic information to a geographical location. For instance, retailers,

Geographic information system (GIS)
A system that stores and displays information that can be linked to a geographic location.

banks, food chains, gas stations, and print shop franchises can all use geographically coded files from a GIS to conduct demographic analyses. By combining population, age, income, traffic flow, and density figures with geography, a retailer can pinpoint the best location for a new store or restaurant.

Here are some of the geographic databases available in many GISs:

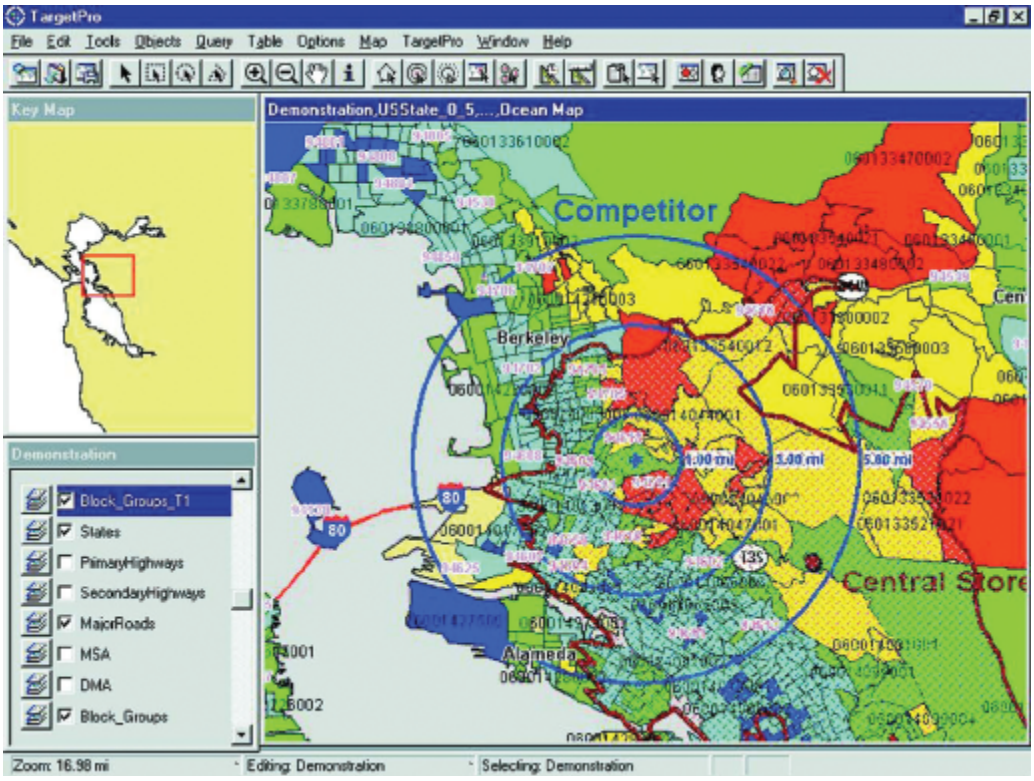
- Census data by block, tract, city, county, congressional district, metropolitan area, state, and zip code
- Maps of every street, highway, bridge, and tunnel in the U.S.
- Utilities such as electrical, water, and gas lines
- All rivers, mountains, lakes, and forests
- All major airports, colleges, and hospitals

For example, airlines use GISs to identify airports where ground services are the most effective. This information is then used to help schedule and to decide where to purchase fuel, meals, and other services.

Commercial office building developers use GISs in the selection of cities for future construction. Building new office space takes several years; therefore, developers value the database approach that a GIS can offer. GIS is used to analyze factors that influence the location decisions by addressing five elements for each city: (1) residential areas, (2) retail shops, (3) cultural and entertainment centers, (4) crime incidence, and (5) transportation options.

Here are five examples of how location-scouting GIS software is turning commercial real estate into a science.

- *Carvel Ice Cream:* This 80-year-old chain of ice cream shops uses GIS to create a demographic profile of what a typically successful neighborhood for a Carvel looks like—mostly in terms of income and ages.
- *Saber Roofing:* Rather than send workers out to estimate the costs for reroofing jobs, this Redwood City, California, firm pulls up aerial shots of the building via Google Earth. The



Geographic information systems (GISs) are used by a variety of firms, including Darden Restaurants, to identify target markets by income, ethnicity, product use, age, etc. Here, data from MapInfo helps with competitive analysis for a retailer. Three concentric blue rings, each representing various mile radii, were drawn around the competitor's store. The heavy red line indicates the "drive" time to the firm's own central store (the red dot).

owner can measure roofs, evaluate their condition, and e-mail the client an estimate, saving hundreds of miles of driving daily. In one case, while on the phone, a potential client was told her roof was too steep for the company to tackle after the Saber employee quickly looked up the home on Google Earth.

- *Arby's:* As this fast-food chain learned, specific products can affect behavior. Using MapInfo, Arby's discovered that diners drove up to 20% farther for their roast beef sandwich (which they consider a "destination" product) than for its chicken sandwich.
- *Home Depot:* Wanting a store in New York City, even though Home Depot demographics are usually for customers who own big homes, the company opened in Queens when GIS software predicted it would do well. Although most people there live in apartments and very small homes, the store has become one of the chain's highest-volume outlets. Similarly, Home Depot thought it had saturated Atlanta two decades ago, but GIS analysis suggested expansion. There are now over 40 Home Depots in that area.
- *Jo-Ann Stores:* This fabric and craft retailer's 70 superstores were doing well a few years ago, but managers were afraid more big-box stores could not justify building expenses. So Jo-Ann used its GIS to create an ideal customer profile—female homeowners with families—and mapped it against demographics. The firm found it could build 700 superstores, which in turn increased the sales from $105 to $150 per square foot.

Other packages similar to MapInfo are Atlas GIS (from Strategic Mapping), ArcGIS (by Esri), SAS/GIS (by SAS Institute), Maptitude (by Caliper), and GeoMedia (by Intergraph).

These GISs can be extensive, including comprehensive sets of map and demographic data. The maps have millions of miles of streets and points of interest to allow users to locate restaurants, airports, hotels, gas stations, ATMs, museums, campgrounds, and freeway exits. Demographic data include statistics for population, age, income, education, and housing. These data can be mapped by state, county, city, zip code, or census tract.

The *Video Case Study* "Locating the Next Red Lobster Restaurant" that appears at the end of this chapter describes how that chain uses its GIS to define trade areas based on market size and population density.

VIDEO 8.2
Locating the Next Red Lobster Restaurant

Summary

Location may determine up to 50% of operating expense. Location is also a critical element in determining revenue for the service, retail, or professional firm. Industrial firms need to consider both tangible and intangible costs. Industrial location problems are typically addressed via a factor-rating method, locational cost–volume analysis, the center-of-gravity method, and the transportation method of linear programming.

For service, retail, and professional organizations, analysis is typically made of a variety of variables including purchasing power of a drawing area, competition, advertising and promotion, physical qualities of the location, and operating policies of the organization.

Key Terms

Tangible costs (p. 380)
Intangible costs (p. 380)
Clustering (p. 382)
Factor-rating method (p. 383)
Locational cost–volume analysis (p. 384)
Center-of-gravity method (p. 386)
Transportation model (p. 387)
Geographic information system (GIS) (p. 389)

Ethical Dilemma

In this chapter, we have discussed a number of location decisions. Consider another: United Airlines announced its competition to select a town for a new billion-dollar aircraft-repair base. The bidding for the prize of 7,500 jobs paying at least $25 per hour was fast and furious, with Orlando offering $154 million in incentives and Denver more than twice that amount. Kentucky's governor angrily rescinded Louisville's offer of $300 million, likening the bidding to "squeezing every drop of blood out of a turnip."

When United finally selected from among the 93 cities bidding on the base, the winner was Indianapolis and its $320 million offer of taxpayers' money.

But a few years later, with United near bankruptcy, and having fulfilled its legal obligation, the company walked away from the massive center. This left the city and state governments out all that money, with no new tenant in sight. The city now even owns the tools, neatly arranged in each of the 12 elaborately equipped hangar bays. United outsourced its maintenance to mechanics at a southern firm (which pays one-third of what United paid in salary and benefits in Indianapolis).

What are the ethical, legal, and economic implications of such location bidding wars? Who pays for such giveaways? Are local citizens allowed to vote on offers made by their cities, counties, or states? Should there be limits on these incentives?

Discussion Questions

1. How is FedEx's location a competitive advantage? Discuss.
2. Why have many manufacturing facilities relocated from Western Europe to Asia? Discuss the motives and risks.
3. Jaguar Land Rover has opened its first plant in China in 2014. Discuss the main reason for this decision.
4. What is clustering?
5. How does factor weighting incorporate personal preference in location choices?
6. What are the advantages and disadvantages of a qualitative (as opposed to a quantitative) approach to location decision making?
7. Quickly review the location of shops and services in your local shopping centre. Can you find examples of clustering in the retail sector?
8. What are the major factors that firms consider when choosing a country in which to locate?
9. What factors affect region/community location decisions?
10. Although most organizations may make the location decision infrequently, there are some organizations that make the decision quite regularly and often. Provide one or two examples. How might their approach to the location decision differ from the norm?
11. List factors, other than globalization, that affect the location decision.
12. How can the centre-of-gravity method be used to find the best locations for local services such as public libraries, medical centres, or post offices? What constraints should be considered when the method is used in large, congested cities?
13. What are the three steps to locational cost–volume analysis?
14. "Manufacturers locate near their resources, retailers locate near their customers." Discuss this statement, with reference to the proximity-to-markets arguments covered in the text. Can you think of a counter-example in each case? Support your choices.
15. Why shouldn't low wage rates alone be sufficient to select a location?
16. Distribution centres has a key role to assure quick home deliveryof the products, in online sales. What techniques can be employed by retailers to select the best locations for their distribution centres?
17. Contrast the location of a food distributor and a supermarket. (The distributor sends truckloads of food, meat, produce, etc., to the supermarket.) Show the relevant considerations (factors) they share; show those where they differ.
18. Asda, a leading supermarket in the UK, is taking its click-and-collect service (where customers can order online and collect their items from the collection points) to train stations across London for the first time as part of a wider charge to expand its collection service to areas not currently served by its stores and increase its presence across the capital. It is part of Asda's efforts to increase the number of click-and-collect locations from 218 to over 1,000 in the next five years. Identify the factors that should be considered by Asda to locate the click-and-collect service points.

Using Software to Solve Location Problems

This section presents three ways to solve location problems with computer software. First, you can create your own spreadsheets to compute factor ratings, the center of gravity, and locational cost–volume analysis. Second, Excel OM (free with your text and found in MyOMLab) is programmed to solve all three models. Third, POM for Windows is also found in MyOMLab and can solve all problems labeled with a P.

CREATING YOUR OWN EXCEL SPREADSHEETS

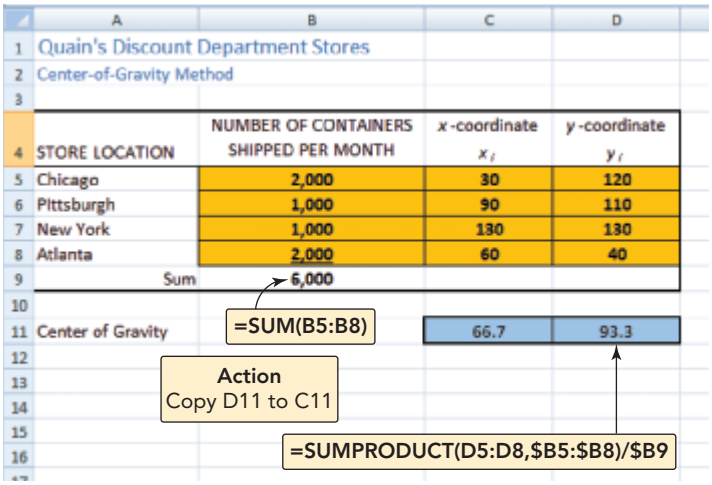
Excel spreadsheets are easily developed to solve most of the problems in this chapter. Consider the Quain's Department Store center-of-gravity analysis in Example 3. You can see from Program 8.1 how the formulas are created.

X USING EXCEL OM

Excel OM may be used to solve Example 1 (with the Factor Rating module), Example 2 (with the Cost–Volume Analysis module), and Example 3 (with the Center-of-Gravity module), as well as other location problems. The factor-rating method was illustrated in Chapter 2.

P USING POM FOR WINDOWS

POM for Windows also includes three different facility location models: the factor-rating method, the center-of-gravity model, and locational cost–volume analysis. For details, refer to Appendix IV.



Program **8.1**

An Excel Spreadsheet for Creating a Center-of-Gravity Analysis for Example 3, Quain's Discount Department Stores

Solved Problems

Virtual Office Hours help is available in MyOMLab.

SOLVED PROBLEM 8.1

Just as cities and communities can be compared for location selection by the weighted approach model, as we saw earlier in this chapter, so can actual site decisions within those cities. Table 8.7 illustrates four factors of importance to Washington, DC, and the health officials charged with opening that city's first public drug treatment clinic. Of primary concern (and given a weight of 5) was location of the clinic so it would be as accessible as possible to the largest number of patients. Due to a tight budget, the annual lease cost was also of some concern. A suite in the city hall, at 14th and U Streets, was highly rated because its rent would be free. An old office building near the downtown bus station received a much lower rating because of its cost. Equally important as lease cost was the need for confidentiality of patients and, therefore, for a relatively inconspicuous clinic. Finally, because so many of the staff at the clinic would be donating their time, the safety, parking, and accessibility of each site were of concern as well.

Using the factor-rating method, which site is preferred?

SOLUTION

From the three rightmost columns in Table 8.7, the weighted scores are summed. The bus terminal area has a low score and can be excluded from further consideration. The other two sites are virtually identical in total score. The city may now want to consider other factors, including political ones, in selecting between the two remaining sites.

TABLE 8.7 Potential Clinic Sites in Washington, DC

		*POTENTIAL LOCATIONS**			*WEIGHTED SCORES*		
FACTOR	IMPORTANCE WEIGHT	HOMELESS SHELTER (2ND AND D, SE)	CITY HALL (14TH AND U, NW)	BUS TERMINAL AREA (7TH AND H, NW)	HOMELESS SHELTER	CITY HALL	BUS TERMINAL AREA
Accessibility for addicts	5	9	7	7	45	35	35
Annual lease cost	3	6	10	3	18	30	9
Inconspicuous	3	5	2	7	15	6	21
Accessibility for health staff	2	3	6	2	6	12	4
					Total scores: 84	83	69

*All sites are rated on a 1 to 10 basis, with 10 as the highest score and 1 as the lowest.

SOLVED PROBLEM 8.2

Ching-Chang Kuo is considering opening a new foundry in Denton, Texas; Edwardsville, Illinois; or Fayetteville, Arkansas, to produce high-quality rifle sights. He has assembled the following fixed-cost and variable-cost data:

		PER-UNIT COSTS		
LOCATION	FIXED COST PER YEAR	MATERIAL	VARIABLE LABOR	OVERHEAD
Denton	$200,000	$ .20	$ .40	$ .40
Edwardsville	$180,000	$ .25	$ .75	$ .75
Fayetteville	$170,000	$1.00	$1.00	$1.00

a) Graph the total cost lines.
b) Over what range of annual volume is each facility going to have a competitive advantage?
c) What is the volume at the intersection of the Edwardsville and Fayetteville cost lines?

SOLUTION

a) A graph of the total cost lines is shown in Figure 8.5.
b) Below 8,000 units, the Fayetteville facility will have a competitive advantage (lowest cost); between 8,000 units and 26,666 units, Edwardsville has an advantage; and above 26,666, Denton has the advantage. (We have made the assumption in this problem that other costs—that is, delivery and intangible factors—are constant regardless of the decision.)
c) From Figure 8.5, we see that the cost line for Fayetteville and the cost line for Edwardsville cross at about 8,000. We can also determine this point with a little algebra:

$$\$180{,}000 + 1.75Q = \$170{,}000 + 3.00Q$$
$$\$10{,}000 = 1.25Q$$
$$8{,}000 = Q$$

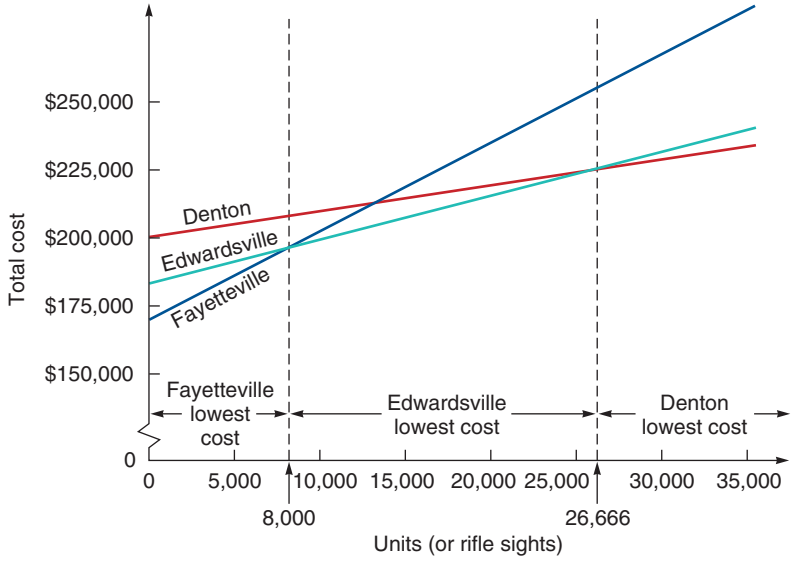


Figure 8.5
Graph of Total Cost Lines for Ching-Chang Kuo

SOLVED PROBLEM 8.3

The Metropolis Public Library plans to expand with its first major branch library in the city's growing north side. The branch will serve six census tracts. Here are the coordinates of each tract and the population within it:

CENSUS TRACT	CENTER OF TRACT	POPULATION IN TRACT
503—Logan Square	(3, 4)	45,000
519—Albany Park	(4, 5)	25,000
522—Rogers Park	(3, 6)	62,000
538—Kentwood	(4, 7)	51,000
540—Roosevelt	(2, 3)	32,000
561—Western	(5, 2)	29,000

Using the center-of-gravity method, what should be the coordinate location of the branch library?

SOLUTION

$$x\text{-coordinate} = \frac{\sum_i x_i Q_i}{\sum_i Q_i} = \frac{3(45{,}000) + 4(25{,}000) + 3(62{,}000) + 4(51{,}000) + 2(32{,}000) + 5(29{,}000)}{244{,}000} = 3.42$$

$$y\text{-coordinate} = \frac{\sum_i y_i Q_i}{\sum_i Q_i} = \frac{4(45{,}000) + 5(25{,}000) + 6(62{,}000) + 7(51{,}000) + 3(32{,}000) + 2(29{,}000)}{244{,}000} = 4.87$$

The new branch library will sit just west of Logan Square and Rogers Park, at the (3.42, 4.87) tract location.

Problems

Note: PX means the problem may be solved with POM for Windows and/or Excel OM.

Problems 8.1–8.4 relate to Factors That Affect Location Decisions

• **8.1** In Myanmar (formerly Burma), 6 laborers, each making the equivalent of $3 per day, can produce 40 units per day. In rural China, 10 laborers, each making the equivalent of $2 per day, can produce 45 units. In Billings, Montana, 2 laborers, each making $60 per day, can make 100 units. Based on labor costs only, which location would be most economical to produce the item?

• **8.2** Refer to Problem 8.1. Shipping cost from Myanmar to Denver, Colorado, the final destination, is $1.50 per unit. Shipping cost from China to Denver is $1 per unit, while the shipping cost from Billings to Denver is $.25 per unit. Considering both labor and transportation costs, which is the most favorable production location?

•• **8.3** You have been asked to analyze the bids for 200 polished disks used in solar panels. These bids have been submitted by three suppliers: Thailand Polishing, India Shine, and Sacramento Glow. Thailand Polishing has submitted a bid of 2,000 baht. India Shine has submitted a bid of 2,000 rupees. Sacramento Glow has submitted a bid of $200. You check with your local bank and find that $1 = 10 baht and $1 = 8 rupees. Which company should you choose?

• **8.4** Refer to Problem 8.3. If the final destination is New Delhi, India, and there is a 30% import tax, which firm should you choose?

Problems 8.5–8.34 relate to Methods of Evaluating Location Alternatives

•• **8.5** Subway, with more than 25,000 outlets in the U.S., is planning for a new restaurant in Buffalo, New York. Three locations are being considered. The following table gives the factors for each site.

FACTOR	WEIGHT	MAITLAND	BAPTIST CHURCH	NORTHSIDE MALL
Space	.30	60	70	80
Costs	.25	40	80	30
Traffic density	.20	50	80	60
Neighborhood income	.15	50	70	40
Zoning laws	.10	80	20	90

a) At which site should Subway open the new restaurant?
b) If the weights for Space and Traffic density are reversed, how would this affect the decision? PX

• **8.6** Ken Gilbert owns the Knoxville Warriors, a minor league baseball team in Tennessee. He wishes to move the Warriors south, to either Mobile (Alabama) or Jackson (Mississippi). The table below gives the factors that Gilbert thinks are important, their weights, and the scores for Mobile and Jackson.

FACTOR	WEIGHT	MOBILE	JACKSON
Incentive	.4	80	60
Player satisfaction	.3	20	50
Sports interest	.2	40	90
Size of city	.1	70	30

a) Which site should he select?
b) Jackson just raised its incentive package, and the new score is 75. Why doesn't this impact your decision in part (a)? PX

•• **8.7** The Brazilian fast growing economy has been largely dependent on its freight transport capacity. A recent study has categorised the country's containership sea port terminals into three distinct groups based on the competitiveness criteria (listed in the table below),and their scores against the competitiveness criteria (scores between 1 and 10, and the higher scores are the better):

CRITERIA OF COMPETITIVENESS	TERMINAL GROUPS		
	1	2	3
Number of containers handled	1	4	7
Berth length	4	9	5
Number of berths	4	6	6
Delay time for mooring	2	3	4
Berth depth	2	3	3
Terminal tariffs	3	4	5
Medium consignment rate	3	4	6
Medium board	2	3	4
Delay time for load/unload	2	6	4

Adapted from: Cabral, A. M. R., & de Sousa Ramos, F. (2014). Cluster analysis of the competitiveness of container ports in Brazil. *Transportation Research Part A: Policy and Practice, 69*, 423-431.

If all criteria have the same level of significance, which terminal group is the best choice for a containership line?

•• **8.8** Marilyn Helm Retailers is attempting to decide on a location for a new retail outlet. At the moment, the firm has three alternatives—stay where it is but enlarge the facility; locate along the main street in nearby Newbury; or locate in a new shopping mall in Hyde Park. The company has selected the four factors listed in the following table as the basis for evaluation and has assigned weights as shown:

FACTOR	FACTOR DESCRIPTION	WEIGHT
1	Average community income	.30
2	Community growth potential	.15
3	Availability of public transportation	.20
4	Labor availability, attitude, and cost	.35

Helm has rated each location for each factor, on a 100-point basis. These ratings are given below:

	LOCATION		
FACTOR	PRESENT LOCATION	NEWBURY	HYDE PARK
1	40	60	50
2	20	20	80
3	30	60	50
4	80	50	50

a) What should Helm do?
b) A new subway station is scheduled to open across the street from the present location in about a month, so its third factor score should be raised to 40. How does this change your answer? PX

•• **8.9** A location analysis for Cook Controls, a small manufacturer of parts for high-technology cable systems, has been narrowed down to four locations. Cook will need to train assemblers, testers, and robotics maintainers in local training centers. Lori Cook, the president, has asked each potential site to offer training programs, tax breaks, and other industrial incentives. The critical factors, their weights, and the ratings for each location are shown in the following table. High scores represent favorable values.

		LOCATION			
FACTOR	WEIGHT	AKRON, OH	BILOXI, MS	CARTHAGE, TX	DENVER, CO
Labor availability	.15	90	80	90	80
Technical school quality	.10	95	75	65	85
Operating cost	.30	80	85	95	85
Land and construction cost	.15	60	80	90	70
Industrial incentives	.20	90	75	85	60
Labor cost	.10	75	80	85	75

a) Compute the composite (weighted average) rating for each location.
b) Which site would you choose?
c) Would you reach the same conclusion if the weights for operating cost and labor cost were reversed? Recompute as necessary and explain. PX

••• **8.10** Pan American Refineries, headquartered in Houston, must decide among three sites for the construction of a new oil-processing center. The firm has selected the six factors listed below as a basis for evaluation and has assigned rating weights from 1 to 5 on each factor:

FACTOR	FACTOR NAME	RATING WEIGHT
1	Proximity to port facilities	5
2	Power-source availability and cost	3
3	Workforce attitude and cost	4
4	Distance from Houston	2
5	Community desirability	2
6	Equipment suppliers in area	3

Subhajit Chakraborty, the CEO, has rated each location for each factor on a 1- to 100-point basis.

FACTOR	LOCATION A	LOCATION B	LOCATION C
1	100	80	80
2	80	70	100
3	30	60	70
4	10	80	60
5	90	60	80
6	50	60	90

a) Which site will be recommended based on *total* weighted scores?
b) If location B's score for Proximity to port facilities was reset at 90, how would the result change?
c) What score would location B need on Proximity to port facilities to change its ranking? PX

•• **8.11** A company is planning on expanding and building a new plant in one of three Southeast Asian countries. Chris Ellis, the manager charged with making the decision, has determined that five key success factors can be used to evaluate the prospective countries. Ellis used a rating system of 1 (least desirable country) to 5 (most desirable) to evaluate each factor.

KEY SUCCESS FACTOR	WEIGHT	*CANDIDATE COUNTRY RATINGS*		
		TAIWAN	THAILAND	SINGAPORE
Technology	0.2	4	5	1
Level of education	0.1	4	1	5
Political and legal aspects	0.4	1	3	3
Social and cultural aspects	0.1	4	2	3
Economic factors	0.2	3	3	2

a) Which country should be selected for the new plant?
b) Political unrest in Thailand results in a lower score, 2, for Political and legal aspects. Does your conclusion change?
c) What if Thailand's score drops even further, to a 1, for Political and legal aspects? PX

• **8.12** Harden College is contemplating opening a European campus where students from the main campus could go to take courses for 1 of the 4 college years. At the moment, it is considering five countries: The Netherlands, Great Britain, Italy, Belgium, and Greece. The college wishes to consider eight factors in its decision. The first two factors are given weights of 0.2, while the rest are assigned weights of 0.1. The following table illustrates its assessment of each factor for each country (5 is best).

FACTOR	FACTOR DESCRIPTION	THE NETHER-LANDS	GREAT BRITAIN	ITALY	BELGIUM	GREECE
1	Stability of government	5	5	3	5	4
2	Degree to which the population can converse in English	4	5	3	4	3
3	Stability of the monetary system	5	4	3	4	3
4	Communications infrastructure	4	5	3	4	3
5	Transportation infrastructure	5	5	3	5	3
6	Availability of historic/cultural sites	3	4	5	3	5
7	Import restrictions	4	4	3	4	4
8	Availability of suitable quarters	4	4	3	4	3

a) In which country should Harden College choose to set up its European campus?
b) How would the decision change if the "degree to which the population can converse in English" was not an issue? PX

••8.13 Daniel Tracy, owner of Martin Manufacturing, must expand by building a new factory. The search for a location for this factory has been narrowed to four sites: A, B, C, or D. The following table shows the results thus far obtained by Tracy by using the factor-rating method to analyze the problem. The scale used for each factor scoring is 1 through 5.

FACTOR	WEIGHT	SITE SCORES			
		A	B	C	D
Quality of labor	10	5	4	4	5
Construction cost	8	2	3	4	1
Transportation costs	8	3	4	3	2
Proximity to markets	7	5	3	4	4
Taxes	6	2	3	3	4
Weather	6	2	5	5	4
Energy costs	5	5	4	3	3

a) Which site should Tracy choose?
b) If site D's score for Energy costs increases from a 3 to a 5, do results change?
c) If site A's Weather score is adjusted to a 4, what is the impact? What should Tracy do at this point? PX

•••8.14 An American consulting firm is planning to expand globally by opening a new office in one of four countries: Germany, Italy, Spain, or Greece. The chief partner entrusted with the decision, L. Wayne Shell, has identified eight key success factors that he views as essential for the success of any consultancy. He used a rating system of 1 (least desirable country) to 5 (most desirable) to evaluate each factor.

KEY SUCCESS FACTOR	WEIGHT	CANDIDATE COUNTRY RATINGS			
		GERMANY	ITALY	SPAIN	GREECE
Level of education					
Number of consultants	.05	5	5	5	2
National literacy rate	.05	4	2	1	1
Political aspects					
Stability of government	0.2	5	5	5	2
Product liability laws	0.2	5	2	3	5
Environmental regulations	0.2	1	4	1	3
Social and cultural aspects					
Similarity in language	0.1	4	2	1	1
Acceptability of consultants	0.1	1	4	4	3
Economic factors					
Incentives	0.1	2	3	1	5

a) Which country should be selected for the new office?
b) If Spain's score were lowered in the Stability of government factor, to a 4, how would its overall score change? On this factor, at what score for Spain *would* the rankings change? PX

••8.15 A British hospital chain wishes to make its first entry into the U.S. market by building a medical facility in the Midwest, a region with which its director, Doug Moodie, is comfortable because he got his medical degree at Northwestern University. After a preliminary analysis, four cities are chosen for further consideration. They are rated and weighted according to the factors shown below:

FACTOR	WEIGHT	CITY			
		CHICAGO	MILWAUKEE	MADISON	DETROIT
Costs	2.0	8	5	6	7
Need for a facility	1.5	4	9	8	4
Staff availability	1.0	7	6	4	7
Local incentives	0.5	8	6	5	9

a) Which city should Moodie select?
b) Assume a minimum score of 5 is now required for all factors. Which city should be chosen? PX

••8.16 The fixed and variable costs for three potential manufacturing plant sites for a rattan chair weaver are shown:

SITE	FIXED COST PER YEAR	VARIABLE COST PER UNIT
1	$ 500	$11
2	1,000	7
3	1,700	4

a) Over what range of production is each location optimal?
b) For a production of 200 units, which site is best? PX

• 8.17 Peter Billington Stereo, Inc., supplies car radios to auto manufacturers and is going to open a new plant. The company is undecided between Detroit and Dallas as the site. The

fixed costs in Dallas are lower due to cheaper land costs, but the variable costs in Dallas are higher because shipping distances would increase. Given the following costs:

COST	DALLAS	DETROIT
Fixed costs	$600,000	$800,000
Variable costs	$28/radio	$22/radio

a) Perform an analysis of the volume over which each location is preferable.
b) How does your answer change if Dallas's fixed costs increase by 10%? PX

•••**8.18** Hyundai Motors is considering three sites—A, B, and C—at which to locate a factory to build its new-model automobile, the Hyundai Sport C150. The goal is to locate at a minimum-cost site, where cost is measured by the annual fixed plus variable costs of production. Hyundai Motors has gathered the following data:

SITE	ANNUALIZED FIXED COST	VARIABLE COST PER AUTO PRODUCED
A	$10,000,000	$2,500
B	$20,000,000	$2,000
C	$25,000,000	$1,000

The firm knows it will produce between 0 and 60,000 Sport C150s at the new plant each year, but, thus far, that is the extent of its knowledge about production plans.
a) For what values of volume, V, of production, if any, is site C a recommended site?
b) What volume indicates site A is optimal?
c) Over what range of volume is site B optimal? Why? PX

••**8.19** Peggy Lane Corp., a producer of machine tools, wants to move to a larger site. Two alternative locations have been identified: Bonham and McKinney. Bonham would have fixed costs of $800,000 per year and variable costs of $14,000 per standard unit produced. McKinney would have annual fixed costs of $920,000 and variable costs of $13,000 per standard unit. The finished items sell for $29,000 each.
a) At what volume of output would the two locations have the same profit?
b) For what range of output would Bonham be superior (have higher profits)?
c) For what range would McKinney be superior?
d) What is the relevance of break-even points for these cities? PX

••**8.20** The following table gives the map coordinates and the shipping loads for a set of cities that we wish to connect through a central hub.

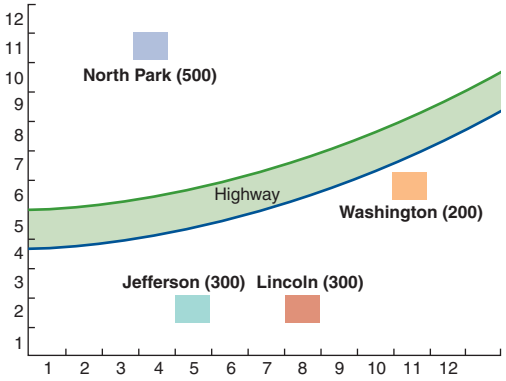
CITY	MAP COORDINATE (X, Y)	SHIPPING LOAD
A	(5, 10)	5
B	(6, 8)	10
C	(4, 9)	15
D	(9, 5)	5
E	(7, 9)	15
F	(3, 2)	10
G	(2, 6)	5

a) Near which map coordinates should the hub be located?
b) If the shipments from city A triple, how does this change the coordinates? PX

••**8.21** A chain of home health care firms in Louisiana needs to locate a central office from which to conduct internal audits and other periodic reviews of its facilities. These facilities are scattered throughout the state, as detailed in the following table. Each site, except for Houma, will be visited three times each year by a team of workers, who will drive from the central office to the site. Houma will be visited five times a year. Which coordinates represent a good central location for this office? What other factors might influence the office location decision? Where would you place this office? Explain. PX

CITY	MAP COORDINATES	
	x	y
Covington	9.2	3.5
Donaldsonville	7.3	2.5
Houma	7.8	1.4
Monroe	5.0	8.4
Natchitoches	2.8	6.5
New Iberia	5.5	2.4
Opelousas	5.0	3.6
Ruston	3.8	8.5

••**8.22** A small rural county has experienced unprecedented growth over the past 6 years, and as a result, the local school district built the new 500-student North Park Elementary School. The district has three older and smaller elementary schools: Washington, Jefferson, and Lincoln. Now the growth pressure is being felt at the secondary level. The school district would like to build a centrally located middle school to accommodate students and reduce busing costs. The older middle school is adjacent to the high school and will become part of the high school campus.
a) What are the coordinates of the central location?
b) What other factors should be considered before building a school? PX



••**8.23** Todd's Direct, a major TV sales chain headquartered in New Orleans, is about to open its first outlet in Mobile, Alabama, and wants to select a site that will place the new outlet in the center of Mobile's population base. Todd examines the seven census tracts in Mobile, plots the coordinates of the center of each from a map, and looks up the population base in each to use as a weighting. The information gathered appears in the following table.

CENSUS TRACT	POPULATION IN CENSUS TRACT	*X, Y* MAP COORDINATES
101	2,000	(25, 45)
102	5,000	(25, 25)
103	10,000	(55, 45)
104	7,000	(50, 20)
105	10,000	(80, 50)
106	20,000	(70, 20)
107	14,000	(90, 25)

a) At what center-of-gravity coordinates should the new store be located?
b) Census tracts 103 and 105 are each projected to grow by 20% in the next year. How will this influence the new store's coordinates? PX

••••**8.24** Twenty Four Seven Convenience Store, which had opened its first store at New Delhi's Lajpat Nagar in 2005, presently operates 38 'round-the-clock' stores in the India's capital region[1]. Planning to open its new branch in the capital suburban, the chain has come up with three options which have been evaluated against the decision factors are follows:

		Location		
FACTORS	WEIGHT	A	B	C
Market Size	30	8	6	5
Accessibility	30	6	5	6
Proximity to the current 24-7's distribution centres	25	5	6	4
Store expansion potential	15	5	6	9

[1]*Source:* http://www.thehindu.com/news/cities/Delhi/twenty-four-seven-store-chain-in-expansion-mode/article6327828.ece

a) Using the factor-rating method, what is the recommended site for Twenty Four Seven's new store?
b) The store expansion potential is the least important factor in the least. At what level of importance (weight) for the store' expansion potential, the decision made in part (a) of this question will change.

••••**8.25** The EU has made changes in airline regulation that dramatically affect major European carriers such as British International Air (BIA), KLM, Air France, Alitalia, and Swiss International Air. With ambitious expansion plans, BIA has decided it needs a second service hub on the continent, to complement its large Heathrow (London) repair facility. The location selection is critical, and with the potential for 4,000 new skilled blue-collar jobs on the line, virtually every city in western Europe is actively bidding for BIA's business.

After initial investigations by Holmes Miller, head of the Operations Department, BIA has narrowed the list to 9 cities. Each is then rated on 12 factors, as shown in the table below.

a) Help Miller rank the top three cities that BIA should consider as its new site for servicing aircraft.
b) After further investigation, Miller decides that an existing set of hangar facilities for repairs is not nearly as important as earlier thought. If he lowers the weight of that factor to 30, does the ranking change?
c) After Miller makes the change in part (b), Germany announces it has reconsidered its offer of financial incentives, with an additional 200-million-euro package to entice BIA. Accordingly, BIA has raised Germany's rating to 10 on that factor. Is there any change in top rankings in part (b)? PX

Additional problems **8.26–8.34** *are available in* MyOMLab.

DATA FOR PROBLEM 8.25		*LOCATION*								
		ITALY			*FRANCE*			*GERMANY*		
FACTOR	IMPORTANCE WEIGHT	MILAN	ROME	GENOA	PARIS	LYON	NICE	MUNICH	BONN	BERLIN
Financial incentives	85	8	8	8	7	7	7	7	7	7
Skilled labor pool	80	4	6	5	9	9	7	10	8	9
Existing facility	70	5	3	2	9	6	5	9	9	2
Wage rates	70	9	8	9	4	6	6	4	5	5
Competition for jobs	70	7	3	8	2	8	7	4	8	9
Ease of air traffic access	65	5	4	6	2	8	8	4	8	9
Real estate cost	40	6	4	7	4	6	6	3	4	5
Communication links	25	6	7	6	9	9	9	10	9	8
Attractiveness to relocating executives	15	4	8	3	9	6	6	2	3	3
Political considerations	10	6	6	6	8	8	8	8	8	8
Expansion possibilities	10	10	2	8	1	5	4	4	5	6
Union strength	10	1	1	1	5	5	5	6	6	6

CASE STUDIES

Finding a Location for Electronics Component Manufacturing in Asia

ACM is an electronics component manufacturer that has been located in Singapore since 1991, supplying original equipment manufacturers (OEMs) with quality components. In the past several years, ACM has experienced increasing pressure from other manufacturers located in other countries. In Singapore, while labor remains quite inexpensive, there has been a relatively steady increase in labor costs. In addition, utility costs—most notably water and energy costs—have led the firm to contemplate moving operations elsewhere in Asia in an attempt to make the firm more competitive. ACM remains profitable, but margins have shrunk, and management is interested in ensuring that the firm remains competitive against other component manufacturers in the medium term to long term.

A senior management team has formed a committee to reach a decision regarding possible relocation. The committee has identified two additional locations as possible candidates for relocation: Hong Kong (People's Republic of China [PRC]) and Kuching (Malaysia). Hong Kong's main attractions stem from the fact that since 1997, when its sovereignty was transferred back to the PRC, labor costs have decreased as access to labor has increased. Hong Kong enjoys a large seaport and very good transportation infrastructure, and this is important in moving in raw materials and moving out finished components to customers. Presently, the customers are geographically dispersed, making access to a seaport very important in delivering products to customers. Senior management believes that an increasing number of OEMs will move to the PRC in the next several years, as has been the case in the past decade. This will only increase the attractiveness of locating the manufacturing facility in Hong Kong.

Kuching is located in the Malaysian province of Sarawak, on the island of Borneo. It is the fourth-largest city in Malaysia and home to a population of around 650,000. Several points make Kuching attractive to the relocation committee. First, locating here would provide access to natural resources and other production inputs. Second, the transportation infrastructure is good, and the city hosts a deep sea port for moving raw materials in and finished goods out. That said, the port is not as large or accessible as those of Hong Kong or Singapore, and several committee members have expressed concern about the frequency of ship visits to Kuching. If the port does not receive regular service from container ships, transportation costs to ship components to OEMs will increase. Finally, another selling point is that labor is relatively stable and inexpensive in Malaysia.

The committee has contacted the government of Singapore to elicit possible incentives to not relocate to another country. Singapore is offering a 5-year exemption on taxes for ACM if the plant remains in Singapore. The government will also assist by partially subsidizing labor, water, and energy costs for 5 years. Committee members realize that the Singapore plant, which has been operating for years, has already been amortized, and opening a new plant would require additional capital costs. That said, opening a new factory would also provide an opportunity to upgrade production equipment to more productive and energy efficient alternatives.

Discussion Questions

1. What advantages and disadvantages does each potential location offer?
2. What other relevant factors that are not mentioned in this case study might play a role in the team's decision?
3. Why is transportation infrastructure so important in this decision?
4. This is a long-term, strategic decision; what factors might change in the next 10 to 20 years? How will the possibility of such changes influence the decision?
5. Which alternative would you recommend, under which circumstances?

Source: Dr. Ian M. Langella, Shippensburg University, USA.

Locating the Next Red Lobster Restaurant

Video Case 

From its first Red Lobster in 1968, the chain has grown to 705 locations, with over $2.6 billion in U.S. sales annually. The casual dining market may be crowded, with competitors such as Chili's, Ruby Tuesday, Applebee's, TGI Friday's, and Outback, but Red Lobster's continuing success means the chain thinks there is still plenty of room to grow. Robert Reiner, director of market development, is charged with identifying the sites that will maximize new store sales without cannibalizing sales at the existing Red Lobster locations.

Characteristics for identifying a good site have not changed in 40 years; they still include real estate prices, customer age, competition, ethnicity, income, family size, population density, nearby hotels, and buying behavior, to name just a few. What *has* changed is the powerful software that allows Reiner to analyze a new site in 5 minutes, as opposed to the 8 hours he spent just a few years ago.

Red Lobster has partnered with MapInfo Corp., whose geographic information system (GIS) contains a powerful module for analyzing a trade area (see the discussion of GIS in the chapter). With the U.S. geo-coded down to the individual block, MapInfo allows Reiner to create a psychographic profile of existing and potential Red Lobster trade areas. "We can now target areas with greatest sales potential," says Reiner.

The U.S. is segmented into 72 "clusters" of customer profiles by MapInfo. If, for example, cluster #7, Equestrian Heights (see MapInfo description below), represents 1.7% of a household base within a Red Lobster trade area, but this segment also accounts

for 2.4% of sales, Reiner computes that this segment is effectively spending 1.39 times more than average (Index = 2.4/1.7) and adjusts his analysis of a new site to reflect this added weight.

CLUSTER	PSYTE 2003	SNAP SHOT DESCRIPTION
7	Equestrian Heights	They may not have a stallion in the barn, but they likely pass a corral on the way home. These families with teens live in older, larger homes adjacent to, or between, suburbs but not usually tract housing. Most are married with teenagers, but 40% are empty nesters. They use their graduate and professional school education—56% are dual earners. Over 90% are white, non-Hispanic. Their mean family income is $99,000, and they live within commuting distance of central cities. They have white-collar jobs during the week but require a riding lawn mower to keep the place up on weekends.

When Reiner maps the U.S., a state, or a region for a new site, he wants one that is at least 3 miles from the nearest Red Lobster and won't negatively impact its sales by more than 8%; MapInfo pinpoints the best spot. The software also recognizes the nearness of non-Red Lobster competition and assigns a probability of success (as measured by reaching sales potential).

The specific spot selected depends on Red Lobster's seven real estate brokers, whose list of considerations include proximity to a vibrant retail area, proximity to a freeway, road visibility, nearby hotels, and a corner location at a primary intersection.

"Picking a new Red Lobster location is one of the most critical functions we can do," says Reiner. "And the software we use serves as an independent voice in assessing the quality of an existing or proposed location."

Discussion Questions*

1. Visit the Web site for PSTYE 2003 (**www.gemapping.com/downloads/targetpro_brochure.pdf**). Describe the psychological profiling (PSYTE) clustering system. Select an industry, other than restaurants, and explain how the software can be used for that industry.
2. What are the major differences in site location for a restaurant versus a retail store versus a manufacturing plant?
3. Red Lobster also defines its trade areas based on market size and population density. Here are its seven density classes:

DENSITY CLASS	DESCRIPTION	HOUSEHOLDS PER SQ. MILE
1	Super Urban	8,000+
2	Urban	4,000–7,999
3	Light Urban	2,000–3,999
4	First Tier Suburban	1,000–1,999
5	Second Tier Suburban	600–999
6	Exurban/Small	100–599
7	Rural	0–99

Note: Density classes are based on the households and land area within 3 miles of the geography (e.g., census tract) using population-weighted centroids.

The majority (92%) of the Red Lobster restaurants fall into three of these classes. Which three classes do you think the chain has the most restaurants in? Why?

*You may wish to view the video that accompanies this case before answering the questions.

Where to Place the Hard Rock Cafe

Video Case

Some people would say that Oliver Munday, Hard Rock's vice president for cafe development, has the best job in the world. Travel the world to pick a country for Hard Rock's next cafe, select a city, and find the ideal site. It's true that selecting a site involves lots of incognito walking around, visiting nice restaurants, and drinking in bars. But that is not where Mr. Munday's work begins, nor where it ends. At the front end, selecting the country and city first involves a great deal of research. At the back end, Munday not only picks the final site and negotiates the deal but then works with architects and planners and stays with the project through the opening and first year's sales.

Munday is currently looking heavily into global expansion in Europe, Latin America, and Asia. "We've got to look at political risk, currency, and social norms—how does our brand fit into the country," he says. Once the country is selected, Munday focuses on the region and city. His research checklist is extensive, as seen in the accompanying table.

Site location now tends to focus on the tremendous resurgence of "city centers," where nightlife tends to concentrate. That's what Munday selected in Moscow and Bogota, although in both locations he chose to find a local partner and franchise the operation. In these two political environments, "Hard Rock wouldn't dream of operating by ourselves," says Munday. The location decision also is at least a 10- to 15-year commitment by Hard Rock, which employs tools such as locational cost–volume

Hard Rock's Standard Market Report (for offshore sites)

A. Demographics (local, city, region, SMSA), with trend analysis
   1. Population of area
   2. Economic indicators
B. Visitor market, with trend analysis
   1. Tourists/business visitors
   2. Hotels
   3. Convention center
   4. Entertainment
   5. Sports
   6. Retail
C. Transportation
   1. Airport ← subcategories include: (a) age of airport (b) no. of passengers (c) airlines (d) direct flights (e) hubs
   2. Rail
   3. Road
   4. Sea/river
D. Restaurants and nightclubs (a selection in key target market areas)
E. Political risk
F. Real estate market
G. Hard Rock Cafe comparable market analysis

analysis to help decide whether to purchase land and build, or to remodel an existing facility.

Currently, Munday is considering four European cities for Hard Rock's next expansion. Although he could not provide the names, for competitive reasons, the following is known:

FACTOR	EUROPEAN CITY UNDER CONSIDERATION				IMPORTANCE OF THIS FACTOR AT THIS TIME
	A	B	C	D	
A. Demographics	70	70	60	90	20
B. Visitor market	80	60	90	75	20
C. Transportation	100	50	75	90	20
D. Restaurants/ nightclubs	80	90	65	65	10
E. Low political risk	90	60	50	70	10
F. Real estate market	65	75	85	70	10
G. Comparable market analysis	70	60	65	80	10

Discussion Questions*

1. From Munday's Standard Market Report checklist, select any other four categories, such as population (A1), hotels (B2), or restaurants/nightclubs (D), and provide three subcategories that should be evaluated. (See item C1 [airport] for a guide.)
2. Which is the highest rated of the four European cities under consideration, using the table?
3. Why does Hard Rock put such serious effort into its location analysis?
4. Under what conditions do you think Hard Rock prefers to franchise a cafe?

*You may wish to view the video case before answering the questions.

- **Additional Case Study:** Visit MyOMLab for this free case study:
  Southwestern University (E): The university faces three choices as to where to locate its football stadium.

Endnote

1. Equations (8-1) and (8-2) compute a center of gravity (COG) under "squared Euclidean" distances and may actually result in transportation costs slightly (less than 2%) higher than an *optimal* COG computed using "Euclidean" (straight-line) distances. The latter, however, is a more complex and involved procedure mathematically, so the formulas we present are generally used as an attractive substitute. See C. Kuo and R. E. White, "A Note on the Treatment of the Center-of-Gravity Method in Operations Management Textbooks," *Decision Sciences Journal of Innovative Education* 2: 219–227.

Chapter 8 *Rapid* Review

Main Heading	Review Material	MyOMLab
THE STRATEGIC IMPORTANCE OF LOCATION (pp. 340–341)	Location has a major impact on the overall risk and profit of the company. Transportation costs alone can total as much as 25% of the product's selling price. When all costs are considered, location may alter total operating expenses as much as 50%. Companies make location decisions relatively infrequently, usually because demand has outgrown the current plant's capacity or because of changes in labor productivity, exchange rates, costs, or local attitudes. Companies may also relocate their manufacturing or service facilities because of shifts in demographics and customer demand. Location options include (1) expanding an existing facility instead of moving, (2) maintaining current sites while adding another facility elsewhere, and (3) closing the existing facility and moving to another location. For industrial location decisions, the location strategy is usually minimizing costs. For retail and professional service organizations, the strategy focuses on maximizing revenue. Warehouse location strategy may be driven by a combination of cost and speed of delivery. *The objective of location strategy is to maximize the benefit of location to the firm.* When innovation is the focus, overall competitiveness and innovation are affected by (1) the presence of high-quality and specialized inputs such as scientific and technical talent, (2) an environment that encourages investment and intense local rivalry, (3) pressure and insight gained from a sophisticated local market, and (4) local presence of related and supporting industries.	Concept Questions: 1.1–1.4 **VIDEO 8.1** Hard Rock's Location Selection
FACTORS THAT AFFECT LOCATION DECISIONS (pp. 341–344)	Globalization has taken place because of the development of (1) market economics; (2) better international communications; (3) more rapid, reliable travel and shipping; (4) ease of capital flow between countries; and (5) large differences in labor costs. Labor cost per unit is sometimes called the *labor content* of the product: Labor cost per unit = Labor cost per day ÷ Production (that is, units per day) Sometimes firms can take advantage of a particularly favorable exchange rate by relocating or exporting to (or importing from) a foreign country. ■ **Tangible costs**—Readily identifiable costs that can be measured with some precision. ■ **Intangible costs**—A category of location costs that cannot be easily quantified, such as quality of life and government. Many service organizations find that proximity to market is *the* primary location factor. Firms locate near their raw materials and suppliers because of (1) perishability, (2) transportation costs, or (3) bulk. ■ **Clustering**—Location of competing companies near each other, often because of a critical mass of information, talent, venture capital, or natural resources.	Concept Questions: 2.1–2.4 Problems: 8.1–8.4
METHODS OF EVALUATING LOCATION ALTERNATIVES (pp. 344–350)	■ **Factor-rating method**—A location method that instills objectivity into the process of identifying hard-to-evaluate costs. The six steps of the factor-rating method are: 1. Develop a list of relevant factors called *key success factors.* 2. Assign a weight to each factor to reflect its relative importance in the company's objectives. 3. Develop a scale for each factor (for example, 1 to 10 or 1 to 100 points). 4. Have management score each location for each factor, using the scale in step 3. 5. Multiply the score by the weight for each factor and total the score for each location. 6. Make a recommendation based on the maximum point score, considering the results of other quantitative approaches as well. ■ **Locational cost–volume analysis**—A method used to make an economic comparison of location alternatives. The three steps to locational cost–volume analysis are: 1. Determine the fixed and variable cost for each location. 2. Plot the costs for each location, with costs on the vertical axis of the graph and annual volume on the horizontal axis. 3. Select the location that has the lowest total cost for the expected production volume.	Concept Questions: 3.1–3.4 Problems: 8.5–8.34 Virtual Office Hours for Solved Problems: 8.1, 8.2 **ACTIVE MODEL 8.1**

Chapter 8 *Rapid* Review *continued*

Main Heading	Review Material	MyOMLab
	■ **Center-of-gravity method**—A mathematical technique used for finding the best location for a single distribution point that services several stores or areas. The center-of-gravity method chooses the ideal location that minimizes the *weighted* distance between itself and the locations it serves, where the distance is weighted by the number of containers shipped, Q_i: x-coordinate of the center of gravity $= \sum_i x_i Q_i \div \sum_i Q_i$ (8-1) y-coordinate of the center of gravity $= \sum_i y_i Q_i \div \sum_i Q_i$ (8-2) ■ **Transportation model**—A technique for solving a class of linear programming problems. The transportation model determines the best pattern of shipments from several points of supply to several points of demand to minimize total production and transportation costs.	Virtual Office Hours for Solved Problem: 8.3
SERVICE LOCATION STRATEGY (pp. 350–351)	The eight major determinants of volume and revenue for the service firm are: 1. Purchasing power of the customer-drawing area 2. Service and image compatibility with demographics of the customer-drawing area 3. Competition in the area 4. Quality of the competition 5. Uniqueness of the firm's and competitors' locations 6. Physical qualities of facilities and neighboring businesses 7. Operating policies of the firm 8. Quality of management	Concept Questions: 4.1–4.4
GEOGRAPHIC INFORMATION SYSTEMS (pp. 351–353)	■ **Geographic information system (GIS)**—A system that stores and displays information that can be linked to a geographic location. Some of the geographic databases available in many GISs include (1) census data by block, tract, city, county, congressional district, metropolitan area, state, and zip code; (2) maps of every street, highway, bridge, and tunnel in the U.S.; (3) utilities such as electrical, water, and gas lines; (4) all rivers, mountains, lakes, and forests; and (5) all major airports, colleges, and hospitals.	Concept Questions: 5.1–5.4 **VIDEO 8.2** Locating the Next Red Lobster Restaurant

Self Test

■ **Before taking the self-test,** refer to the learning objectives listed at the beginning of the chapter and the key terms listed at the end of the chapter.

LO 8.1 The factors involved in location decisions include
- **a)** foreign exchange.
- **b)** attitudes.
- **c)** labor productivity.
- **d)** all of the above.

LO 8.2 If Emarat Car Wash pays Dh40 per day to a worker in its main facility in Dubai, and twoemployeeswashforty cars per day, the labour cost/car is
- **a)** Dh 40
- **b)** Dh 1
- **c)** Dh 0.5
- **d)** Dh 20
- **e)** Dh 2

LO 8.3 Evaluating location alternatives by comparing their composite (weighted-average) scores involves
- **a)** factor-rating analysis.
- **b)** cost–volume analysis.
- **c)** transportation model analysis.
- **d)** linear regression analysis.
- **e)** crossover analysis.

LO 8.4 On cost–volume analysis chart in location selection decisions, where two cost curves cross each other is also named no-difference point, because:
- **a)** The volumes of the decisions are not different in that point
- **b)** The variable costs of the decisions are not different in that point
- **c)** The total costs of the decisions are not different in that point
- **d)** Both curves have different costs in different points
- **e)** The fixed costs of the decisions are not different in that point

LO 8.5 A regional bookstore chain is about to build a distribution center that is centrally located for its eight retail outlets. It will most likely employ which of the following tools of analysis?
- **a)** Assembly-line balancing
- **b)** Load–distance analysis
- **c)** Center-of-gravity model
- **d)** Linear programming
- **e)** All of the above

LO 8.6 The location decisions in the service and manufacturing sector mainly focus on revenue and cost. However, in public sector services such as hospitals, there are other key factors which should lead the location decisions for example (select two):
- **a)** Accessibility
- **b)** Potential profitability for local businesses
- **c)** Nearby facilities (e.g. parking space)
- **d)** Potential growth of the real estate market
- **e)** Utility costs

Answers: LO 8.1. d; LO 8.2. e; LO 8.3. a; LO 8.4. c; LO 8.5. c; LO 8.6. a.