CHAPTER

16

Site Selection for Services

LEARNING OBJECTIVES *The material in this chapter prepares students to:*

- Use factor rating systems and regression to find locations for demand-sensitive services.
- Use Geographic Information Systems.
- Understand methods for locating back-office services.
- Be able to create a mathematical model for locating a service network.

Selecting a site for most service firms is a fundamentally different problem than selecting a site for most manufacturing facilities. Consequently, even if the topic of "site selection" or "location" has been studied in a previous class in operations management, this chapter is still applicable. Selecting a site for a manufacturing plant is done infrequently, and the basis for the decision is often centered on reducing costs usually through tax concessions from local governments or exploiting inexpensive labor. For example, in the 1990s Hynix Semiconductor, BMW, and Mercedes-Benz received tens of millions of dollars in tax breaks to build plants in Oregon, South Carolina, and Alabama, respectively.

For service firms, however, the site selection problem can be a frequent one. It is not unusual for a "hot" retailing firm to add several hundred new stores in a year. For example, Dollar General, a 6,700-store chain, opened 600–700 new stores each year for the past few years. The location decision is often not based on lowering costs—and the vast majority of service outlets are too small for governments to give anything in the way of tax incentives. The decision usually centers on how the location will help generate revenue.

For many service firms, site selection poses the most important operational decision faced. A poor location can doom a facility to failure regardless of how well it is managed. Despite its importance, this decision is still one that most firms struggle with—a decision often made with far more "gut feel" and opinion than science and fact.

Types of Service Firms

Different types of services have very different needs regarding site selection and use radically different methods to attack this problem. Consequently, this chapter is organized by the type of service firm (see Figure 16.1).

Demand-Sensitive Services

The goal of site selection in a demand-sensitive service is to attract customers through location. Prominent examples include most of the service firms a consumer will visit, such as banks, restaurants, and retail stores. The problem of site selection is most critical in this type of business, since it is the customers who have to be enticed to travel to the service site, rather than employees being ordered to travel to the customer. The difference between the best site and a reasonably good site for delivered services or quasi-manufacturing services might reduce overall profits a few percentage points. The difference between the reasonably good and best site in demand-sensitive services is the difference between profit and loss.

Delivered Services

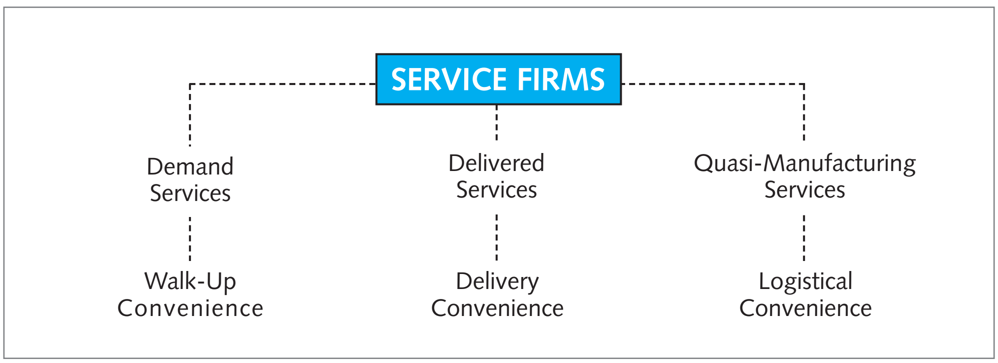
The goal in delivered services is to use multiple locations to cover a geographic area effectively. Examples in the public sector include fire and police protection, postal facilities, and emergency medicine. Private sector examples include food delivery, package delivery, private medical services (e.g., private ambulance services), and repair services (for example, business computer repair, where downtime represents lost customer orders). A retail "saturation strategy" that is used in many industries, such as grocers and convenience stores, also is helped by the methods covered in this section.

Quasi-Manufacturing Services

The goal in these services is to minimize the logistical cost of a multiple location network. Examples include the back-office processing centers of banks and insurance companies, warehouses, hotel reservation centers and other call centers, and many firms in the wholesaling industry.

Other types of service firm location decisions include locating a corporate headquarters, an Internet-based service, or finding a location for duplicate systems in case of a primary system disaster, for example. Those location decisions, however, are more idiosyncratic, and do not lend themselves as readily to the type of analysis that will be discussed here.

FIGURE 16.1: *Types of Service Firms and the Main Goal of Siting*



Site Selection for Demand-Sensitive Services

Consider finding a location for a mid-priced restaurant. A good site would be characterized by a long list of attributes: It would be good to be close to business offices, be easily accessed, be in an area with high traffic, include ample parking, room for expansion, good competitive factors, a nice local government for zoning variances and taxes, and be inexpensive to lease, among others. Even for those who never worked in retail, banking, or a restaurant, it is fairly simple to draw up a long list of characteristics that would make for good retail locations.

Unfortunately, just creating a list of criteria and getting the necessary data isn't enough. If a developer finds a potential site that is better than all the rest on all criteria, the immediate action to take is to wake up because it is only a dream. Among the sites scouted for a demand-sensitive service, one will be lower in cost, another have better access, and the third will be closer to customers. What is needed is a method to present and weigh the conflicting advantages of various sites—some way to determine whether, say, being a quarter-mile closer to downtown is better or worse than being a quarter-mile closer to a major university. Without some agreed-upon method, a firm must rely on the biased and often conflicting opinion of individuals.

Two methods that attempt to bring some order to the data are factor rating and regression. A third method for presenting location data that has become popular in recent years will also be discussed: Geographic Information Systems.

None of these methods can replace entirely the art of site selection. All three of the techniques discussed here are meant to augment, rather than replace, human judgment, because none of them are robust enough to take into consideration the full range of detail necessary. These methods are best put to use through data reduction; that is, the sites that score poorly on either a factor rating scheme or a regression analysis are eliminated from consideration, and the few top sites are then further scrutinized.

Factor Rating

In a factor rating system the key criteria for consideration are listed and subjectively assigned weights, then prospective sites are subjectively assigned values for the key criteria, and the assigned values are combined with the criteria weights to determine an overall score for the site.

Table 16.1 shows an example for finding a restaurant site in the Washington, D.C., area. First, important criteria are listed. To keep this example simple we consider only five criteria: "income of neighborhood," "proximity to shopping centers," "accessibility," "visibility," and "traffic." Table 16.1 presents two mathematically identical ways that these criteria can be given numerical rankings. The first method assigns a higher point total to more important criteria, the second method allows each factor to be judged on the same scale—a scale of 1–10 here—and then the score is multiplied by a corresponding percentage depending on the importance of the factor.

Four potential sites for our Washington, D.C., area restaurant are: Springfield, Tyson's Corner, Gaithersburg, and Alexandria. Here, they are ranked according to the second method on Table 16.1. Field agents visit the sites, collect data, and assign a ranking for each factor with each site. Multiplying each rating by the appropriate percentage, Gaithersburg tops the list with a $10(.40) + 10(.25) + 8(.15) + 7(.10) + 8(.10) = 9.20$ factor rating score.

As a site selection system, factor rating offers both advantages and disadvantages. The primary advantage is transparency and ease of use. The simplicity of the system allows everyone involved to easily understand how it works. Also, providing

TABLE 16.1: *Utilizing Factor Rating to Analyze Potential Washington, D.C., Restaurant Sites*

Factors	Range
Income of neighborhood	0–40
Proximity to shopping centers	0–25
Accessibility	0–15
Visibility	0–10
Traffic	0–10

OR

Factors	Scale	Multiplier
Income of neighborhood	0–10	.40
Proximity to shopping centers	0–10	.25
Accessibility	0–10	.15
Visibility	0–10	.10
Traffic	0–10	.10

Potential Sites:	Springfield	Tyson's Corner	Gaithersburg	Alexandria
Income	4	8	10	6
Shopping	2	7	10	4
Access	1	9	8	4
Visibility	6	9	7	6
Traffic	3	8	8	5

TOTAL SCORE:

Springfield	3.15
Tyson's Corner	8.00
Gaithersburg	9.20
Alexandria	5.10

numerical weights up front avoids the endless arguments over whether, say, one "visibility" point is worth one or two "income of neighborhood" points.

Among its substantial disadvantages, however, the weighting of the factors is highly arbitrary. Why is "income of neighborhood" four times more important than "traffic?" Because the "big boss" said so. In actuality, the relationship may be entirely different. The arbitrary nature of this process is compounded by the 1–10 ranking scale. One person may look at the situation and give it a 3, but someone else may call it a 5. Consequently, any ranking of sites that may come out of such a system is highly suspect. In the particular example given, the best use of the numbers at the end of the process is to narrow the field of competitors, rather than pick a winner. That is, look further at the Gaithersburg and Tyson's Corner sites, and perhaps drop putting any more resources into investigating the Springfield and Alexandria sites.

Another problem with factor rating systems, usually discussed in statistics courses, is multicollinearity. That is, several factors that are given weights might be correlated with each other. So instead of measuring different attributes, the factor rating system gives points to the same attribute. For example, if points are given for both the average income of the local area as well as the average housing value, then what is really happening is that income is being doubly weighted. Given the way factor rating systems are used, the best defense against this double weighting is common sense. In the next method discussed, regression, multicollinearity can be detected fairly easily by tests provided in any introductory statistics textbook.

Regression

Using regression as a site selection method is similar to factor rating. In regression, however, the weights that the factors receive are determined by their actual relationship to results, rather than by managerial whim.

The process in building a site selection regression model is different and more complex than factor rating. Because of these differences and the one-time nature of the project of putting together the initial model, calling in outside consultants to assist would be recommended.

One difference lies in the overall objective. In factor rating, the goal is to derive some overall score for a site. This score, however, provides no intrinsic meaning. Gaithersburg's score of 9.2 versus Tyson's Corner's score of 8.0 does not translate directly into 9.2 − 8.0 = 1.2 more in profits, market share, or customer satisfaction. The score from a factor rating model is an abstract entity. The function of a site selection regression model depends on a real objective (or *dependent variable* in regression-speak). Determining what the dependent variable should be is not the easy task it would appear, but the details of that issue are left for Chapter 17. For the purposes of this discussion, the dependent variable of interest will be "profits."

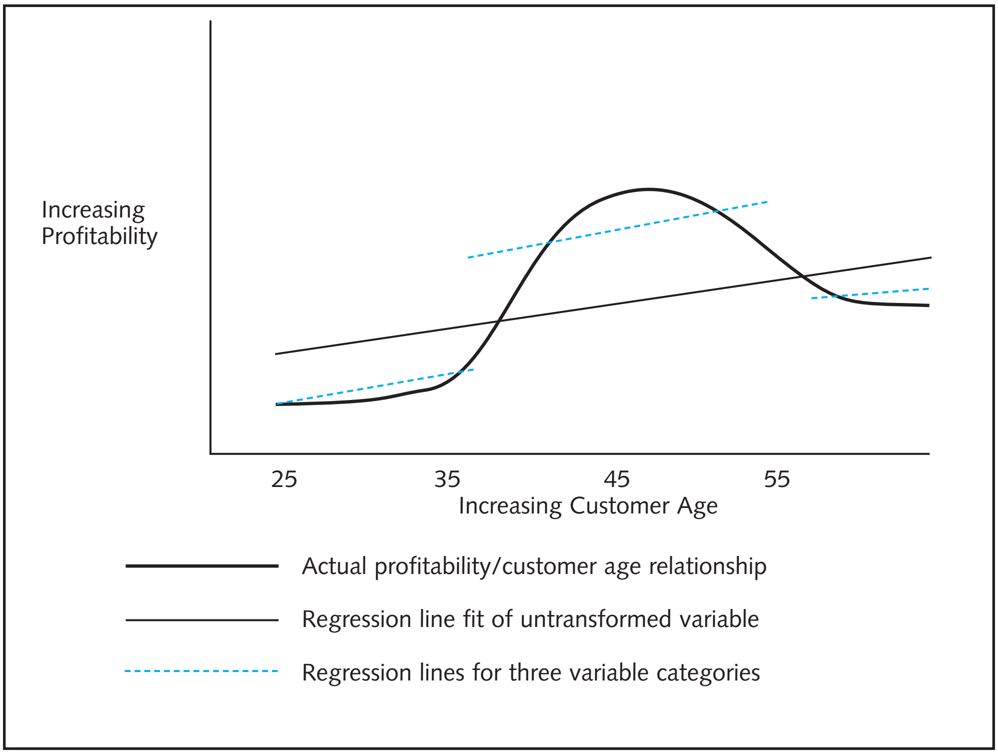
In similar fashion to factor rating models, an initial step in site selection by regression is listing the factors that influence profits. Some of the factors used by First American Bank in the mid-1990s in their site location model can be found in Table 16.2. The next step is quite time consuming; data for all the factors for each existing unit must be collected. The available data are then used in actually converting factors into independent variables that a regression model can use, a process usually called transforming the variables.

Note that the general factors of "age of population" and "income of households" are further broken out into three independent variables. The reason is based on the complexity of the relationship of many independent variables with profitability. As a hypothetical example, profits may be lowest serving a young population, high serving a middle-aged population, and moderate profits achieved serving an older population (Figure 16.2). But the output of a standard regression model is one weighting (the beta coefficient) for each variable. In this case, saying that profits increase, by say, 1% times the population age, is misleading. It may be the average relationship, but it understates profits for middle-aged customers and overstates profits for older customers. In Table 16.2, the "customer age" factor is broken into three independent

TABLE 16.2: *First American Bank Site Selection Independent Variables*

Factors	Independent Variables
Age of population	% of population 25–34 % of population 35–54 % of population 55+
Annual income of households	$20,000–$34,000 $35,000–$49,000 $50,000+
Street placement	1–10 rating
Pedestrian traffic	# pedestrians/5 minutes
Years facility open	years

FIGURE 16.2: *Transforming Variables: Hypothetical Relationship of Profitability and Customer Age*

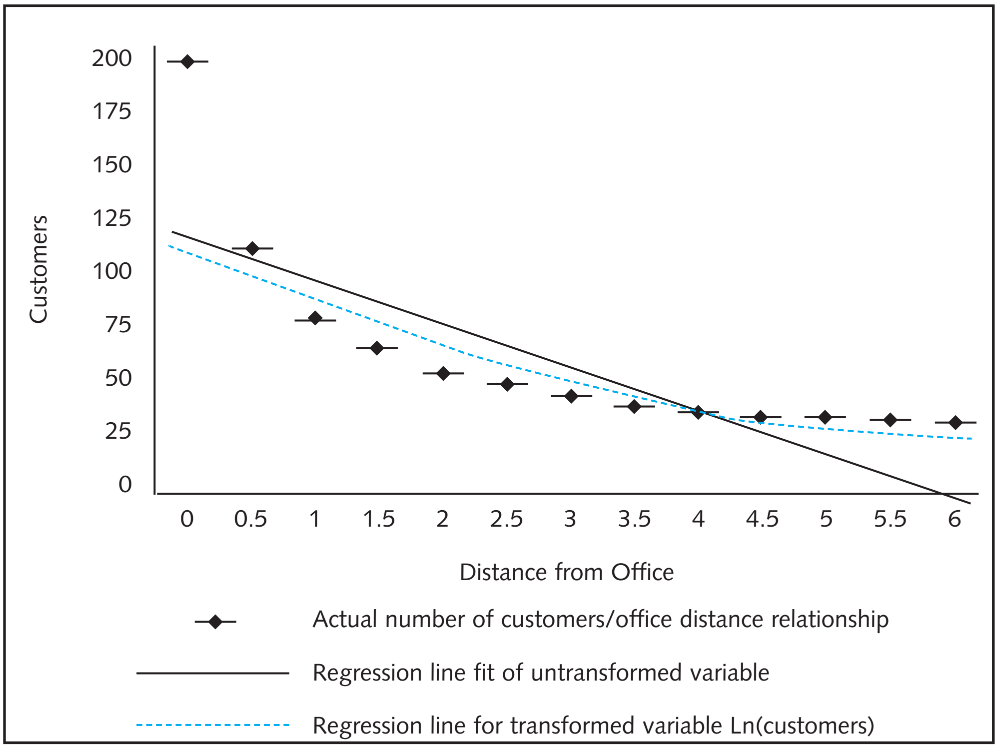


variables that provide a better fit for the true relationship. Here, First American determined three separate age categories would be best. Variables can be transformed, however, in an enormous number of ways. Perhaps four or five categories would have been better, or the upper limit on the "young" category should have been 39 instead of 34. Determining the best variable transformations is a large part of the art of creating regression models for site selection.

Another typical method for transforming variables to use in site selection regressions is to take some reasonable function of the variable. For example, consider the relationship between a restaurant and nearby office space (Figure 16.3). A restaurant located inside a large office building may serve a significant lunch crowd from the building, and the same restaurant located a half mile away would get significantly less traffic. However, if the restaurant were 5 miles away from the office versus 5½ miles away, the drop-off in customers from the extra half mile would be minimal. So, the first half mile is far more important than subsequent half miles. In this example, a simple regression of distance on customers yields the straight line shown, actually predicting a negative number of customers at a 6-mile distance. The regression performed on the function [logarithm(customers)] (that is, taking the logarithm of the number of customers, rather than just the number of customers) yields a better result, as shown by the curved line in Figure 16.3.

Note, however, in Table 16.3, that neither regression truly captured the real benefit of being inside the office building, with the regressions predicting 110 or 116 customers while the actual number is 200, which indicates a better way to view this

FIGURE 16.3: *Transforming Variables: Customer Patronage of a Restaurant and Distance from the Workplace*



More detailed data are available as a Microsoft Excel spreadsheet on your Student CD.

TABLE 16.3: *Transforming Variables in Restaurant Problem*[a]

Dependent Variable: Number of Customers	Independent Variable: Distance from Office (miles)	Regression: Predicting Customers with Untransformed Variable[b]	Regression: Predicting Customers Regressing Distance on Ln(Customers)[c]
200	0.0	116	110
110	0.5	106	95
70	1.0	96	82
60	1.5	86	71
49	2.0	76	61
42	2.5	67	53
37	3.0	57	45
33	3.5	47	39
30	4.0	37	34
28	4.5	27	29
27	5.0	17	25
26	5.5	8	22
25	6.0	–2	19

[a] More detailed data are available as a Microsoft Excel spreadsheet on the text CD.
[b] Regression $R^2 = 0.60$
[c] Regression $R^2 = 0.84$

relationship needs to be found. In this example, one can view the problem as two basic types of restaurants: Type 1—restaurants inside an office building; and Type 2—restaurants that require travel. It might be advisable to create two different regression models for these two different types. For example, Dollar General uses six different regression models for what they perceive as six different store types in their portfolio.

A type of variable needed in a regression model that is not needed in a factor rating model is a variable that explains the profitability of existing units but has no bearing on a new site. Note, for example, that the variable "years facility open" appears in Table 16.2 as a variable used by First American bank in selecting brand new sites. At first glance, it would appear that such a variable would be irrelevant. But consider the data in Table 16.4. If one were to look just at the relationship between "distance from downtown" and "profits," it would seem reasonable to say that new facilities should all be located downtown. However, if the "years facility open" variable is also considered, it becomes clear that being far from downtown may not doom a facility to low profitability, after all.

Even though it adds more science to the issue of site selection, regression also poses several drawbacks. A primary problem is a lack of education. Many longtime real estate employees are simply unaware of regression, so the output numbers seem to come from a mysterious "black box" and are not trusted. The level of statistical uncertainty in regression models also presents a problem. For example, Taco Bell's regression-based models predicted revenue for potential sites. However, the expectations of service personnel are that these predictions should have the accuracy of budget numbers—that is, these predictions should be within a few percentage points of what actually occurs. Because the revenue predictions can be different from actual results by 20% to 30%, real estate personnel felt they were of little value and discontinued their use. However, this assessment indicates a lack of understanding of how to use regression models. These models are best at displaying differences between potential sites, rather than accurately predicting what next year's revenue will be for a specific outlet.

Small chains or new ventures cannot readily use regression for this purpose. Regression requires that a history already be developed; that is, a regression model needs data, so a firm must already have several facilities in the field before they can be analyzed by regression. Further, the best that regression can do is look at how different factors affected last year's profits. It is a blind numerical technique that cannot feel upcoming trends.

TABLE 16.4: *Hypothetical Relationship of Facility Age and Profits*

Number	Profits	Years Facility Open	Distance from Downtown
1	High	10	1
2	High	10	1
3	High	10	1
4	High	10	1
5	High	10	10
6	Low	1	1
7	Low	1	10
8	Low	1	10
9	Low	1	10
10	Low	1	10

Geographic Information Systems

A Geographic Information System (GIS) is computer software that links location to information in an easy-to-use visual format. A GIS is more than just a map on a computer screen. The purpose of site selection GIS is to predict demand based on information stored in geographic databases. For any given point on a map, a GIS system can answer questions such as "How many households within a 5-mile radius have annual incomes over $50,000?" "What is the likely cannibalization effect on my network of stores by placing a store in this location?" "What potential sites in a region are zoned commercial, between 2 and 5 acres, and not in the 100-year flood plain?" "What market share among women, ages 35–50, will a new store located at a specific address take from the existing store network of competitors?"

The first GIS uses were in politics, geology, and environmental planning. For example, congressional redistricting is an exercise that occurs in the United States every 10 years. A possible goal in redistricting is getting as many favorable districts for one's political party as possible. For example, given 3 million Republicans and 3 million Democrats in a state with 11 House of Representative seats, one congressional district could be created with 550,000 Republicans and no Democrats, while the other 10 districts could have 245,000 Republicans and 300,000 Democrats, thus assuring 91% Democrat representation in an evenly divided state. The main tool used to create such political districts is a GIS system. For example, in 2001 in Texas, the state Redistricting Board approved maps that would change the Republican edge in the state house from 78–72 to 88–62.[1]

Due to both increasing computer power and a shift in the marketing programs of leading GIS firms, business uses of GIS grew significantly in the past decade. In addition to using GIS for site selection, other business uses include sales territory partitioning, vehicle routing, or target marketing campaigns. The leading firms in the industry include Tactician, ESRI, Intergraph, GDS, Strategic Mapping, and Mapinfo (a sample of firms using GIS systems is on Table 16.5).

A GIS provided by Tactician Corporation and available on the Internet at http://www.tactician.com is used here as an example. We are trying to find a good site for the new restaurant, MyPlace. Its target market is middle-aged households (ages 35–54) with annual incomes of $50,000–$75,000. We want to find an appropriate locale with a number of potential customers within easy walking or driving distance. The chosen site is the address of 975 Adair Avenue, Atlanta, Georgia. On the

TABLE 16.5: *A Partial List of Geographic Information System Users*

Ace Hardware	DuPont Merck
Anheuser Busch	Hilton Hotels Corporation
Arby's	JCPenney
AT&T	John Deere
Avis	Marks & Spencer
Banc One	McDonald's Corporation
BellSouth	Molly Maid
Blockbuster	OfficeMax
Chemical Bank	Safeway Stores
Chevron	Tesco Stores Ltd.
Coca-Cola	Wells Fargo
Dayton-Hudson	

1. S. Attlesey (2001), "New Maps Could Give GOP Large Minority in Both Houses," *Dallas Morning News*, July 25, p. A1.

MapScape screen (Figure 16.4), three different trade areas are chosen: within a quarter-mile, within a three-minute drive, and within a 10-minute drive.

Figure 16.5 shows the area within a quarter-mile, and Figure 16.6 shows that 49 households in that quarter-mile meet the criteria. (The numbers on figures16.6 and 16.8 are from the 1990 census. Tactician provides material from the 2000 census for a fee.) Figure 16.7 shows the area in which persons are capable of driving to this location within three minutes. Note that the area is irregularly shaped, because this software realizes that one can travel faster on main roads. Figure 16.8 shows that 770 households meet the criteria in this three-minute drive radius.

The software demonstrated here is available over the Internet at http://www.tactician.com. More sophisticated software from the same company contains imbedded mathematical models that can assist in determining the percentage of demand that may be expected from an area, depending upon the competitive environment. One such model is known as the gravity model.

Gravity Model of Demand

The so-called "gravity" models are a set of several variants of a basic theme that sounds quite logical: Given two similar stores, a customer is more likely to go to the closer one. A simplistic interpretation of this idea is that the attraction to a store *j* of the *n* stores in the neighborhood from a customer *i* is based solely on the travel time T_{ij}. So, given several similar stores nearby, the probability P_{ik} of customer i going to a specific store *k* is given by

$$P_{ik} = (1/T_{ik}) / \sum_{j=1}^{n} (1/T_{ij}) \quad (16.1)$$

FIGURE 16.4: *Tactician™ Report Choice*

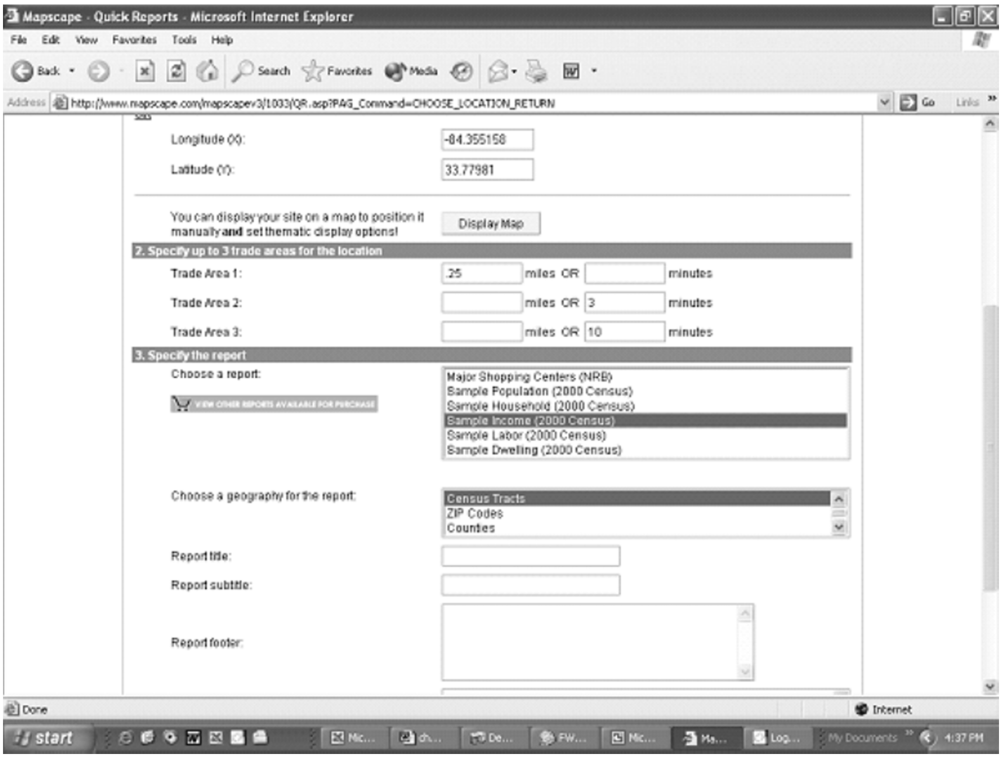


FIGURE 16.5: *Map of Area Within a Quarter-Mile*

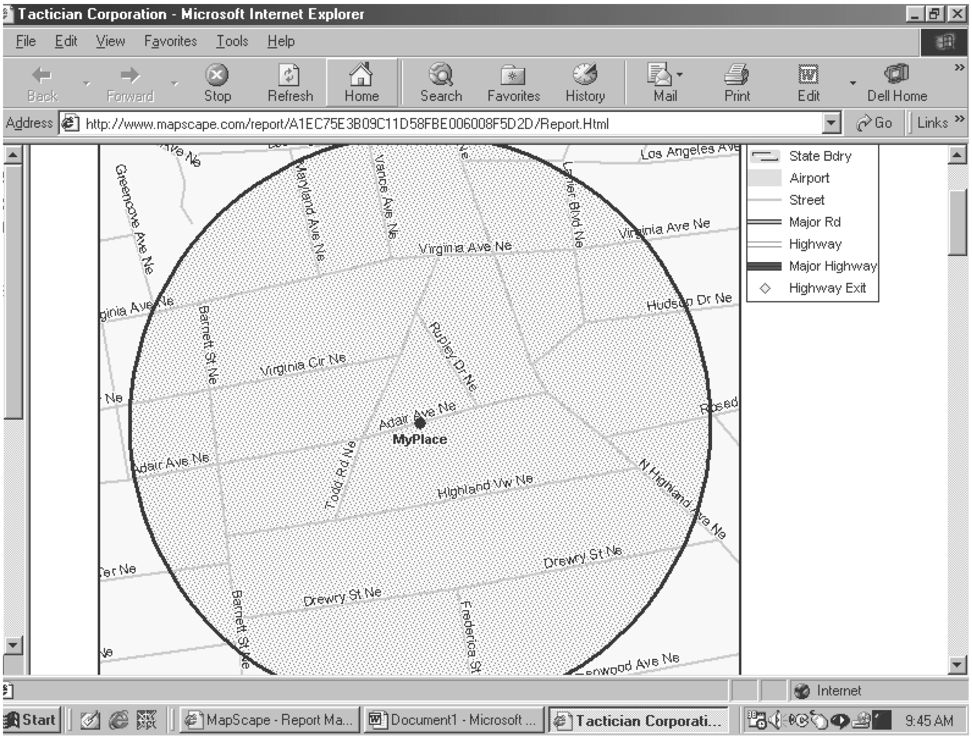
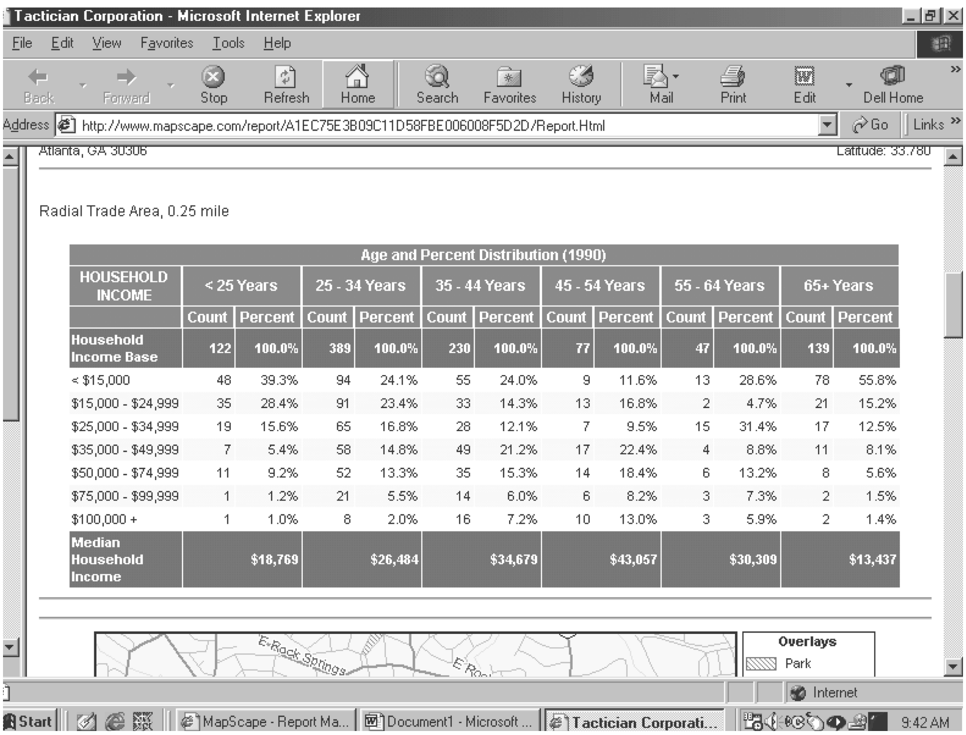


FIGURE 16.6: *Demographic Information of Area Within a Quarter-Mile*



Tactician Corporation - Microsoft Internet Explorer

Address http://www.mapscape.com/report/A1EC75E3B09C11D58FBE006008F5D2D/Report.Html

Atlanta, GA 30306 Latitude: 33.780

Radial Trade Area, 0.25 mile

Age and Percent Distribution (1990)

HOUSEHOLD INCOME	< 25 Years		25 - 34 Years		35 - 44 Years		45 - 54 Years		55 - 64 Years		65+ Years	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Household Income Base	122	100.0%	389	100.0%	230	100.0%	77	100.0%	47	100.0%	139	100.0%
< $15,000	48	39.3%	94	24.1%	55	24.0%	9	11.6%	13	28.6%	78	55.8%
$15,000 - $24,999	35	28.4%	91	23.4%	33	14.3%	13	16.8%	2	4.7%	21	15.2%
$25,000 - $34,999	19	15.6%	65	16.8%	28	12.1%	7	9.5%	15	31.4%	17	12.5%
$35,000 - $49,999	7	5.4%	58	14.8%	49	21.2%	17	22.4%	4	8.8%	11	8.1%
$50,000 - $74,999	11	9.2%	52	13.3%	35	15.3%	14	18.4%	6	13.2%	8	5.6%
$75,000 - $99,999	1	1.2%	21	5.5%	14	6.0%	6	8.2%	3	7.3%	2	1.5%
$100,000 +	1	1.0%	8	2.0%	16	7.2%	10	13.0%	3	5.9%	2	1.4%
Median Household Income		$18,769		$26,484		$34,679		$43,057		$30,309		$13,437

Overlays
Park

Internet

Start MapScape - Report Ma... Document1 - Microsoft ... Tactician Corporati... 9:42 AM

FIGURE 16.7: *Map of Area Within Three-Minute Drive*

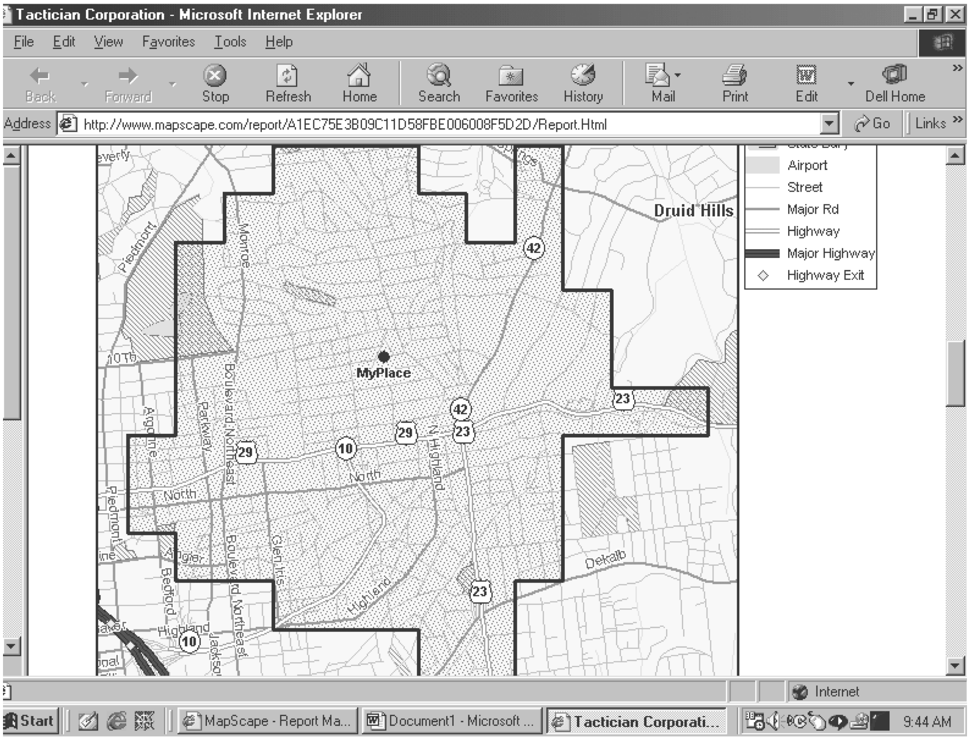
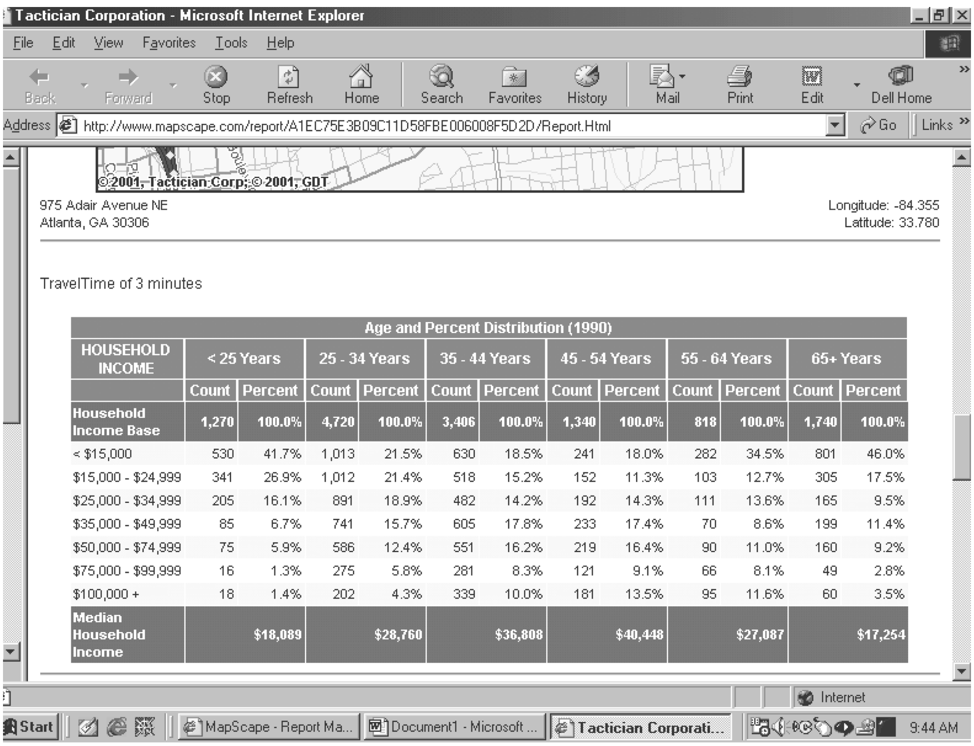


FIGURE 16.8: *Demographic Information of Area Within Three-Minute Drive*



975 Adair Avenue NE
Atlanta, GA 30306

Longitude: -84.355
Latitude: 33.780

TravelTime of 3 minutes

Age and Percent Distribution (1990)												
HOUSEHOLD INCOME	< 25 Years		25 - 34 Years		35 - 44 Years		45 - 54 Years		55 - 64 Years		65+ Years	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Household Income Base	1,270	100.0%	4,720	100.0%	3,406	100.0%	1,340	100.0%	818	100.0%	1,740	100.0%
< $15,000	530	41.7%	1,013	21.5%	630	18.5%	241	18.0%	282	34.5%	801	46.0%
$15,000 - $24,999	341	26.9%	1,012	21.4%	518	15.2%	152	11.3%	103	12.7%	305	17.5%
$25,000 - $34,999	205	16.1%	891	18.9%	482	14.2%	192	14.3%	111	13.6%	165	9.5%
$35,000 - $49,999	85	6.7%	741	15.7%	605	17.8%	233	17.4%	70	8.6%	199	11.4%
$50,000 - $74,999	75	5.9%	586	12.4%	551	16.2%	219	16.4%	90	11.0%	160	9.2%
$75,000 - $99,999	16	1.3%	275	5.8%	281	8.3%	121	9.1%	66	8.1%	49	2.8%
$100,000 +	18	1.4%	202	4.3%	339	10.0%	181	13.5%	95	11.6%	60	3.5%
Median Household Income		$18,089		$28,760		$36,808		$40,448		$27,087		$17,254

Consider the following three stores: Store A is five minutes away, Store B is 10 minutes away, and Store C is 15 minutes away. Equation (16.1) indicates that the probability of going to Store A = 0. 55, Store B = 0.27, and Store C = 0.18. Once a probability is determined, it can be applied to the group under study, such as the number of people in specific census tracts or zip codes.

This simplest of gravity models can accommodate many adaptations. For example, equation (16.1) can be expanded to include factors such as the differential attractiveness of different-sized stores, or particular exponents on the travel time that are industry specific.

Some criticisms can be made of the basic concepts of gravity models. The idea behind a gravity model is that stores that are closer are more attractive. If that is true, then why *ever* go to the more distant store? Simply showing increased probability seems to run counter to the basic argument. Also, most of these gravity models rely on the ratio of travel times. For instance, being 20 minutes away is twice as bad as being 10 minutes away. But is being two seconds away really twice as bad as being one second away, or at short distances, is there really any effect? Further, when a mathematical model is trying to predict patronage it bases the travel time on trips from home. However, consumers often "trip chain" and go to several stores on one trip or travel from the workplace, rather than from home, so the travel time from home may not be relevant.

Site Selection for Delivered Services

The usual goal for delivered services is to either minimize the costs of multiple sites or maximize the effectiveness of limited resources. Management must decide how many facilities to have and where to locate those facilities.

The steps to make these decisions include the following:

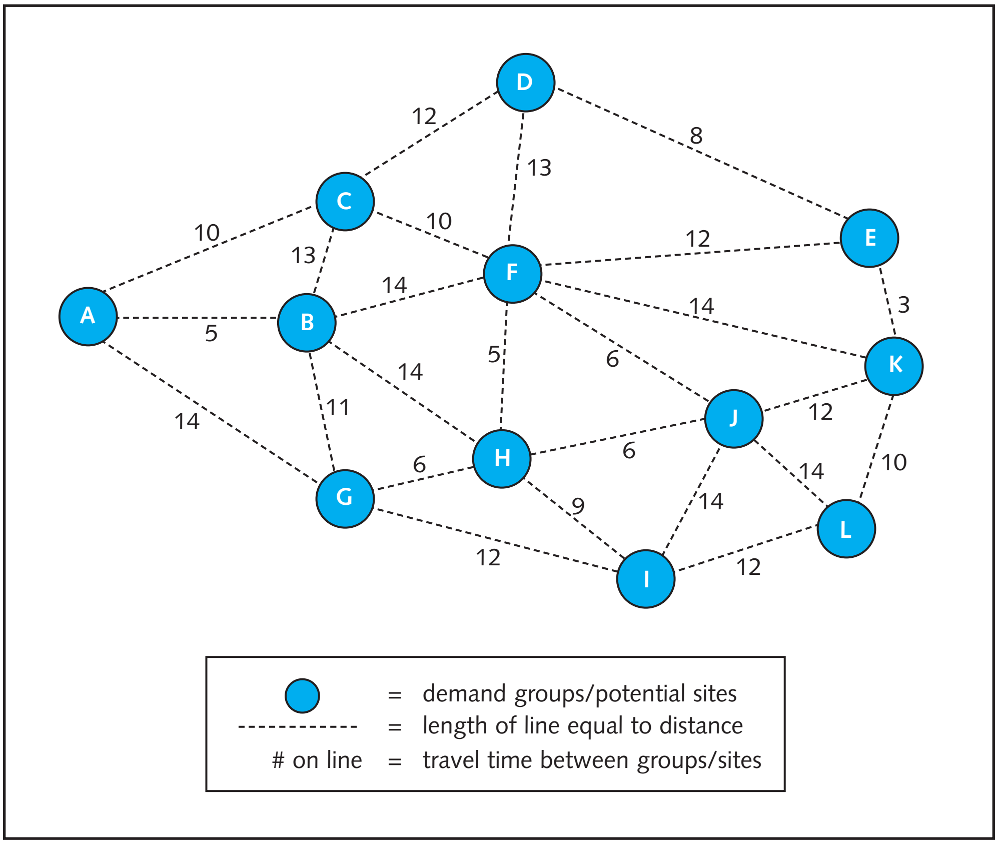
1. *Establish a service goal.* The goals can be simply stated. For example, everyone within a city boundary should be reached by ambulance within 10 minutes. Or they can be more complex, such as a primary ambulance within 10 minutes and a backup within 15 minutes.
2. *Mathematically represent a service area.* Even though a goal of "10 minutes to every home" may be desired, the mathematics behind these problems cannot handle that load—there are too many "homes." What is required is that customers are grouped by census tract, zip code, city section, or city, and the time from any facility to the customer grouping is considered.
3. *Determine demand from service area.* It is not sufficient to know that a computer repair technician can be dispatched to a downtown location in 20 minutes. If 40% of your customers are downtown, will the second caller be required to wait a few hours? Demand must be aggregated by customer grouping so that site capacity is set properly.
4. *List potential sites and determine relationship of sites to demand.* It would be ideal if one could simply determine demand and let a computer run wild finding the appropriate set of sites. However, that option is generally not feasible. A given area contains too many possible sites for most computer programs to handle. A computer may also choose one of too many inappropriate sites because of not enough land and improper zoning among other issues. Also, the relationships of the demand clusters and the potential sites need to be assessed. This decision generally takes a yes or no format: "Can site X meet the demand at customer grouping Y within the established service goal?"

EXAMPLE 16.1

Figure 16.9 depicts a small example for finding locations for an ambulance service. The goal is to have the fewest stations while still serving each area in 12 minutes or less. The 12 demand groups are labeled A through L and represent potential sites. Travel times are noted on the links between the demand groups. Note that the travel times do not always correspond with the physical distance between the points. Due to rivers and bridge placement, hills with no roads over the top, the speed of freeways versus surface streets, heavily congested areas, parks with no through roads, and several other aspects of any city's traffic patterns, 1 mile on a map may take one minute or 10 to travel.

This example is a relatively simple one, but the solution is typically not obvious at first glance. A more realistic problem would be several times this size, and would be more complex in terms of service standards (backup services required) and capacity (certain sites are subject to limited capacity).

FIGURE 16.9: *Example Problem for Delivered Services*



Expected Results

The four-step process outlined earlier will not provide a "perfect" solution. A perfect solution would require considering each household individually and consider every possible location. In the approach outlined, the grouping of demand points and the necessity of inputting possible locations means that the perfect solution will be found only by accident. What this procedure delivers is a good solution, which is more than can be accomplished without an appropriate method.

Consider a likely alternative to this process. Start with one store, which is placed in the best location, add another store placed in the second best location, and so on. (This method is called a "greedy" algorithm by management scientists.) This process can easily lead to the problem shown in Figure 16.10. Given a situation with two pockets of high demand and one store to locate, a greedy algorithm would want to locate right in the middle, so that both markets could be served. When a second store is added, it would make sense to locate it in one of the high-demand markets. However, if one was planning ahead of time, the third solution on Figure 16.10 is clearly the best: Have one store in both high-demand locations.

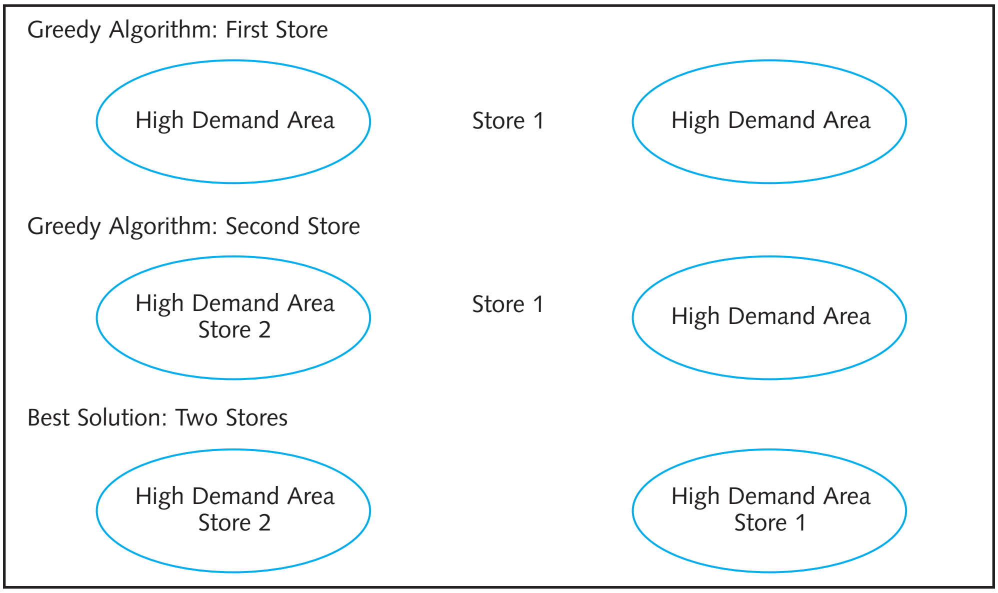
The methods involved become increasingly sophisticated. At American Medical Response, a nationwide, for-profit emergency medical service, their ambulances are not housed at a hospital or fire station. The squadron of ambulances is constantly shifted to different locations throughout the day as units are called on for emergencies. This system allows for faster response time in general, and allows for such shifts as moving most of the fleet from downtown during the day to the bedroom communities at night.

Access your Student CD now for information on mathematical solution methods for delivered services.

Mathematical Solution Methods for Delivered Services

A discussion and examples of these models can be found on the Student CD.

FIGURE 16.10: *Delivered Services: Greedy Algorithm Versus Best Solution*



Site Selection for Quasi-Manufacturing Services

Many service facilities require little face-to-face contact with their customers. Perhaps largest in number are telephone call centers. An estimated 4 to 6.5 million people in the United States work in call centers. Also prevalent in this category are the back-office operations of financial services firms, such as banks and insurance companies. The industry of wholesaling also exhibits this characteristic. For these facilities, the main purpose in site selection is often to minimize costs, rather than attract customers. The managerial decisions to make are how many sites, the location of each site, and the staffing of the resulting facilities.

It would seem that these decisions would be made infrequently, but that is not the case. Warehouses in the wholesaling industry, in particular, are fairly easy to move. In a survey of wholesalers it was found that warehouse location decisions were reviewed annually by 63% of firms. Commercial software is available to help with this problem. At least 16 vendors of such software offer products ranging from $5,000 to $80,000 (see Ballou and Masters, 1993).

The extreme range in prices for software mirrors the complexity and robustness of the products. With all the software available, however, basic flaws remain. None of the packages can provide a truly optimal solution; that is, for a large national or multinational firm, no software can be expected to find the best number, location, and staffing of a network of facilities given only data about customers because the problem is too complex.

The software uses three basic types of methods. They are presented in order of lowest to highest price, and correspondingly, usually lowest to highest efficacy.

- *Heuristics:* A heuristic is a "rule of thumb," but often a highly complex rule. As a simple example, heuristics for warehouse site selection could be similar to the "greedy" algorithm presented earlier. If 10 warehouses are to be placed, start by locating the first warehouse in the best place as if it were the only warehouse; then locate the second warehouse as if only two warehouses were to be placed, and so on. Clearly, this method will not be optimal. Other heuristic approaches however, are more complex and are closer to finding the "best" solution.
- *Deterministic simulation:* In a deterministic simulation software package, costs are input into the software so that if the user chooses a set of locations, the software can provide the overall cost. The weakness results from the requirement that the user supply the specific list of locations.
- *Mixed integer/linear programming:* Linear programming can be used to find the best set of locations among a given list; that is, if the user gives the linear program 100 potential locations, it will pick out the best network of 10 among them. Again, however, the user must list the initial set of locations.

Access your Student CD now for information on mixed linear/integer programming for location selection.

Mixed Linear/Integer Programming for Location Selection

A discussion and examples of these models can be found on the Student CD.

Summary

The location decision is both a fundamental and frequent decision for many service firms. The success of any store is intrinsically linked to attributes of its location. We explored some methods used by several different types of services: demand-sensitive services, delivered services, and quasi-manufacturing services. Factor rating, regression, and GIS offer tools to service firms to determine how to generate demand through their location.

Firms wishing to cover a geographic area can use linear-programming-based tools. Through our ambulance service example, we showed that travel time is just one of many considerations in this decision. With real situations of a larger size, the decision becomes much more complex and can include such factors as service standards and capacity issues to attempt to determine the "best" solution.

Finally, a variety of tools are available for quasi-manufacturing firms that do not require physical contact with customers. These firms desire to minimize their costs by selecting the best location for new sites. Available software, offering a range of complexity and robustness, utilize heuristics, deterministic simulations, or mixed integer/linear programming to determine the most profitable location from the given alternatives.

Review Questions

1. In what ways are service location decisions different from manufacturing location decisions?
2. Services are delineated into three different categories in this chapter: demand-sensitive services, delivered services, and quasi-manufacturing services. Why?
3. Three general types of site location systems were discussed: an informal system, a factor rating system, and regression-based systems. Under what business conditions, if any, should each of these systems be used?
4. In many firms, numerical analysis merely supported a location selection system. Given, say, a bigger sample size for such models, or a model with a high R^2, or other conditions that make these models better, should such models replace, not just augment, "gut feel" managerial decisions? Under what conditions should regression-based models be used to choose specific locations?
5. What are the strengths and weaknesses of GIS systems?
6. What are the basic assumptions underlying the gravity model of demand?
7. What is meant by the phrase *mathematically represent a service area* when forming a plan for a network to deliver services?
8. Mixed integer linear programming is presented as a solution technique for the warehouse location problem. Heuristics are also commonly used. If linear programming provides optimal solutions, why are any other techniques used?

TABLE 16.6: *Data for Problem 16.1*

Site	Access (0.2)	Proximity to Customers (0.4)	Competition (0.2)	Traffic (0.2)
Allendium	7	4	5	9
Beatical	8	6	5	9
Canak	3	9	2	8
Delirouse	4	2	7	5
Everm	8	6	4	6
Fouirt	1	4	3	7
Guerney	7	4	8	4
Hiight	5	1	6	2

Problems

Access your Student CD now for Tables 16.6 through 16.9 as Excel worksheets.

16.1. In finding a location for a new restaurant, the eight sites listed in Table 16.6 were rated on a scale of 1–10 on four attributes. The weighting of each attribute is in parentheses in the column heading. What are the scores of each location? What decision(s) should be made?

16.2. Consider the restaurant location problem again. This time, the historical profitability of each location is listed in Table 16.7. Devise a regression-based system to predict the profitability of a new site, Zwderkan, that has a rating of 5 in every category.

16.3. In finding a location for a new bank branch the eight sites listed on Table 16.8 have been rated on a 1–10 scale on four attributes. The weighting of each attribute is in parentheses in the column heading. What are the scores of each location? What decision(s) should be made?

16.4. Consider the bank branch location problem again. This time, the historical profitability of each location is listed in Table 16.9. Devise a regression-based system to predict the profitability of a new site, Ysard, that has a rating of 6 on Office Space, 2 on Middle Class Population, 8 on Competition, and 1 on Visibility.

16.5. Using http://www.tactician.com, compare two locations in your city to determine which contains the most households with incomes over $50,000 in a half-mile radius, or some other relevant criterion.

TABLE 16.7: *Data for Problem 16.2*

Site	Access	Proximity to Customers	Competition	Traffic	Profit
Allendium	7	4	5	9	$464
Beatical	8	6	5	9	$509
Canak	3	9	2	8	$283
Delirouse	4	2	7	5	$535
Everm	8	6	4	6	$417
Fouirt	1	4	3	7	$259
Guerney	7	4	8	4	$600
Hiight	5	1	6	2	$406

TABLE 16.8: *Data for Problem 16.3*

Site	Office Space (0.25)	Middle Class Population (0.50)	Competition (0.15)	Visibility (0.10)
Ignatius	4	9	5	2
Jaedicom	5	5	3	2
Kalik	1	2	3	8
Laviat	8	2	6	3
Mortruse	4	8	1	4
Nurz	6	8	6	3
Poeatica	8	5	7	4
Quoos	2	4	3	3

TABLE 16.9: *Data for Problem 16.4*

Site	Office Space	Middle Class Population	Competition	Visibility	Profits
Ignatius	4	9	5	2	$396
Jaedicom	5	5	3	2	$276
Kalik	1	2	3	8	$220
Laviat	8	2	6	3	$436
Mortruse	4	8	1	4	$189
Nurz	6	8	6	3	$454
Poeatica	8	5	7	4	$543
Quoos	2	4	3	3	$233

16.6. The hunt is on: Rich's 13-year-old daughter Alexandra is going to give him an introductory trombone concert later in the day, and he wants to purchase earplugs before then. Three stores in the vicinity sell earplugs: EarsPlus, 10 minutes away; ICantBelieveYouBoughtHeraTrombone, 15 minutes away; and KidNoise, 20 minutes away. According to the gravity model, what is the probability Rich will go to each store?

16.7. The people in census track 013411 spend $100,000 in local dress shops, those in census track 013443 spend $80,000, and those in track 013422 spend $200,000. Consider only two dress shops: Ralph's and Lulu's. The travel time from each shop to each area is in Table 16.11. Adapt the gravity model to determine how much will be spent at each shop.

16.8. *This problem requires the quantitative content on the Student CD.* An area wishes to find a fire-fighting strategy that balances cost and response time. Table 16.11 presents a travel time matrix for 11 locations. Any of the locations may be used for a fire station.

TABLE 16.10: *Data for Problem 16.7*

Store	Track 013411	Track 013443	Track 013422
Ralph's	10 minutes	30 minutes	20 minutes
Lulu's	15 minutes	20 minutes	20 minutes

TABLE 16.11: *Data for Problem 16.8*

	1	2	3	4	5	6	7	8	9	10	11
1		39	49	46	45	48	15	24	21	25	26
2	39		13	10	11	12	40	15	20	18	15
3	49	13		3	5	3	35	29	35	30	28
4	46	10	3		2	5	33	26	32	27	25
5	45	11	5	2		3	30	29	34	29	27
6	48	12	3	5	3		33	32	37	32	30
7	15	40	35	33	30	33		33	32	26	28
8	24	15	29	26	29	32	33		3	8	5
9	21	20	35	32	34	37	32	3		6	7
10	25	18	30	27	29	32	26	8	6		3
11	26	15	28	25	27	30	28	5	7	3	

a. If the desired response time is 19 minutes, how many stations are needed and where should they be located? (*Hint:* Adapt equations [16.2], [16.3], and [16.4] and the associated Excel file on the Student CD.)
b. Determine a trade-off curve. Find out what the worst response time would be if only two fire stations could be built, then three stations, then four stations.

Selected Bibliography

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CASE STUDY

Regression-Based Site Selection at La Quinta Hotels[4]

The old adage that says the three most important aspects of real estate are "location, location, location," is especially true in the transient hotel business. The physical site is an essential attribute of a new hotel. No amount of marble in the foyer can bring customers to a poor location, and a good location could profit under mediocre management.

Unfortunately, considerable disagreement can still arise over which sites are better than others. Everyone could agree that a Death Valley Hotel probably would be a poor choice, but it is difficult to determine exactly what makes for a good choice. To be considered beyond the most preliminary investigation, each potential site must have a number of positive aspects. Historically, selecting a site for new La Quinta Inns proved to be decidedly more art than science. Although objective data could be gathered, sifting through the data and finding a good site still requires "gut feel." And everyone's gut feel is a little different. With more difficult economic times and increased industry capacity squeezing La Quinta's profits in early 1987, location decisions required more scrutiny.

La Quinta decided to try a new approach to selecting sites: Using regression analysis of the current performance of their installed inn base to determine sites for new inns. The first test of the approach would be to select a site in the growing Dallas market.

The La Quinta Hotel Chain

Sam Barshop started Barshop Motel Enterprises, Inc., in 1962. In 1972, Barshop Motel Enterprises, Inc., became La Quinta Motor Inns, Inc. (LQM), with 30 inns, and started to expand rapidly. La Quinta grew steadily over the next decade, and by 1987 owned or operated 191 inns in 29 states (Table 16.12). LQM locations are centered in Texas, but LQM expanded throughout the Southeast, Southwest, and Midwest, employing 5,800 people, and showed a profit in the 10 years 1977–1987 (Table 16.13).

Motor inns operated and licensed by La Quinta are positioned in the mid-price, limited service segment of the lodging industry, between luxurious "full service" motor inns and "budget" motels. La Quinta Inns appeal to guests who desire simple rooms and convenient locations and whose needs do not include banquet facilities, meeting rooms, in-house restaurants, cocktail lounges, and room service. Specifically, La Quinta attempts to cater to the frequent business traveler.

4. *Source:* This case is based on the work of Sheryl Kimes and James Fitzsimmons, "Selecting Profitable Hotel Sites at La Quinta Motor Inns," *Interfaces*, 20(2), 1990, pp. 12-20. Information regarding the company background and the site location project for La Quinta Motor Inns, Inc. was obtained from published reports, but the proposed Dallas expansion is fictitious.

CASE STUDY

TABLE 16.12: *La Quinta Owned, Operated, or Licensed Inns*

ALABAMA
Birmingham
Huntsville (2)
Mobile
Montgomery
Tuscaloosa

ARIZONA
Phoenix (2)
Tucson

ARKANSAS
Little Rock (4)

CALIFORNIA
Bakersfield
Chula Vista
Costa Mesa
Fresno
Irvine
Sacramento
San Bernadino
San Diego
Stockton
Vista

COLORADO
Colorado Springs
Denver (7)

FLORIDA
Deerfield Beach
Ft. Myers
Jacksonville (3)
Miami
Orlando
Pensacola
Pinellas Park
Tallahassee (2)
Tampa (2)

GEORGIA
Atlanta (6)
Augusta
Columbus
Savannah

ILLINOIS
Champaign
Chicago (3)
Moline

INDIANA
Indianapolis (2)
Merrillville

KANSAS
Lenexa
Wichita

KENTUCKY
Lexington

LOUISIANA
Baton Rouge
Bossier City
Lafayette
Monroe
New Orleans (5)
Sulphur

MICHIGAN
Kalamazoo

MISSISSIPPI
Jackson

MISSOURI
St. Louis

NEBRASKA
Omaha

NEVADA
Las Vegas
Reno

NEW MEXICO
Albuquerque (3)
Farmington
Santa Fe

NORTH CAROLINA
Charlotte (2)

OHIO
Columbus

OKLAHOMA
Oklahoma City (2)
Tulsa (2)

PENNSYLVANIA
Pittsburgh

SOUTH CAROLINA
Charleston
Columbia
Greenville

TENNESSEE
Knoxville
Memphis (3)
Nashville (2)

TEXAS
Abilene
Amarillo (2)
Austin (4)
Beaumont
Brazosport
Brownsville
College Station
Corpus Christi (2)
Dallas/Ft.Worth (12)
Eagle Pass
El Paso (3)
Harlingen
Houston (12)
Killeen
La Porte
Laredo
Longview
Lubbock
Lufkin
Midland
Nacogdoches
Odessa
San Angelo
San Antonio (11)
Temple
Texarkana
Texas City
Tyler
Victoria
Waco
Wichita Falls

UTAH
Salt Lake City

VIRGINIA
Hampton
Virginia Beach

WASHINGTON
Seattle

WYOMING
Casper Cheyenne
Rock Springs

RODEWAY INN
San Antonio

ROYAL INN
Houston

LICENSED LA QUINTA INNS
ARIZONA
Flagstaff

FLORIDA
Orlando

OHIO
Cincinnati
Dayton

TEXAS
Corpus Christi
Denton
Fort Worth
Galveston
McAllen

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TABLE 16.13: *Selected Financial and Operational Data for La Quinta Inns*

($ millions)

	1987*	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977
Revenue	$177	179	160	137	113	103	83	62	48	39	30
Net operating income	$32	44	40	39	37	NA	NA	NA	NA	NA	NA
Net earnings	$4.1	5.8	9.0	12.8	13.5	12.3	8.6	6.4	4.9	3.7	2.5
Long-term debt	$382	394	313	297	243	190	140	119	87	66	54
Total assets	$623	621	541	504	404	324	229	179	131	97	78
Inns owned or licensed	191	176	157	138	129	112	103	90	78	68	63
Rooms owned or licensed (in thousands)	24.1	22.0	19.6	17.0	15.9	13.6	12.3	10.6	9.1	7.8	7.1

*1987 financial results estimated. All other data as of fiscal year end May 31.

A customer survey in 1981 showed that 83% of La Quinta's guests were business travelers, approximately 80% were regular customers who stayed at La Quinta an average of 10 times a year, and approximately 80% of whom visited a local site within 4 miles of the hotel. The main reasons cited by customers for staying at La Quinta were convenient locations, clean rooms, courteous service, and reasonable rates.

Although La Quinta does not provide any food service at its inns, aside from a continental breakfast offered in its lobbies, it locates adjacent to restaurants or provides funds for construction of adjacent restaurants. La Quinta holds an ownership interest in 87 restaurants operated by third parties, such as Denny's or JoJos.

La Quinta's typical inn is located along an interstate highway or major traffic artery convenient to businesses, contains 100 to 175 guest rooms, provides 24-hour front desk and message service, same-day laundry service, a swimming pool, and in-room color televisions with "Showtime." La Quinta Inns are typically of masonry construction with a distinctive Spanish Colonial architecture.

Individual inns are usually managed by married couples who live on the premises. On a typical day shift they supervise one housekeeping supervisor, eight room attendants, two laundry workers, two general maintenance persons, and a front desk

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sales representative. LQM fully owns about half of the inns that bear its name (Table 16.14). Some inns are 50% partnerships, others are just managed by La Quinta. For nine La Quinta Inns, only the La Quinta name was licensed, with no managerial direction from corporate headquarters. For the licensed and managed inns, LQM provides chain services such as bookkeeping, national advertising, and "teLQuik," a national reservation system.

The mid-price, limited service lodging industry is highly competitive, and La Quinta competes directly with other lodging establishments in all locations. Each of the inns competes with other major chains as well as with other hotels, motels, motor inns, and other lodging establishments not affiliated with any major chain. There is no small number of competitors that are dominant in the industry.

Site Selection at La Quinta

La Quinta considers the selection of sites for its inns to be among the most important factors in its business. Sites are chosen for guest convenience and are generally readily accessible to and visible from interstate highways and major traffic arteries.

TABLE 16.14: *Ownership of La Quinta Inns*

	1987	1981
La Quinta Inns owned by LQM		
Owned 100%	88	33
Owned 52–80%	7	5
Owned 50%[a]	54	44
	149	82
Inns of other names owned by LQM	2	7
Total company owned and operated	151	89
La Quinta Inns managed by LQM[b]	31	0
La Quinta Inns licensed to others[c]	9	14
	191	103

[a] Prudential Insurance has been a joint venture partner since 1971 and was a 50% partner in 28 inns and 16 restaurants in both 1981 and 1987. Metropolitan Life Insurance was a 50% partner in three inns and two restaurants in 1981 and eight inns and four restaurants in 1987.

[b] LQM sold 31 inns it owned 100% to La Quinta Motor Inns Limited Partnership in fiscal 1987. The sale improved cash flow, increased borrowing capacity, and allowed recognition of real estate appreciation.

[c] Licensing of the La Quinta name ceased in 1977. Since fiscal 1981, the company purchased five inns from licensees.

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Other major site criteria include proximity to office centers, the central business district, commercial and industrial concentrations, medical and educational complexes, regional shopping malls, military bases, and airports. La Quinta's expansion strategy is guided by the concepts of (1) clustering, or building multiple inns in the same metropolitan area; (2) adjacency through locating new inns within approximately 300 miles of existing properties; and (3) filling in, or moving into smaller cities (populations less than 100,000) within existing market areas.

Eight people provided input in the site selection process: Four site evaluators physically toured each potential site and gathered information. Robert Moore, Executive Vice President and Chief Development Officer, Thomas Neilon, Vice President of Real Estate, and the Director of Marketing Research evaluated the data and opinions of the site evaluators and expressed opinions of their own. The company president, CEO, and chairman of the board, Sam Barshop, exercised the final say in all site selections.

Unfortunately, the key variables consulted by all those involved in site evaluation were based on "experience" and "gut feel." Everyone agreed that being close to a university, military base, hospital, or downtown led to additional guests at the hotel. What was less definitive was the relative worth of each of these factors. For example, what was better, a site within 1 mile of a moderately large military base or within 3 miles of a large university? The relative weighting of these factors was based strictly on intuition.

Site Selection by Regression

La Quinta desired a less haphazard approach to site selection. Further, the current process was both costly and produced too many disagreements, and the risk of choosing a poor site became more costly in the last half of the 1980s due to the weakening of the Texas economy.

For assistance in selecting sites, Barshop turned to the business school at the University of Texas, Austin. LQM and UT–Austin had a comfortable relationship, with both the president of the university and the business school dean sitting on the LQM board of directors.

The project was supervised by Professor James Fitzsimmons and performed by a doctoral student, Sheryl Kimes. After interviewing the eight individuals involved in site selection, Ms. Kimes compiled a list of the factors they thought affected the success of a La Quinta Inn (Table 16.15).

Although site selection committee members may disagree on which characteristics are more important for a successful hotel, they all agreed that the profitability of a hotel was based on proximity to local attractions. Because of the presumed dependence of profitability on known factors, Ms. Kimes decided to use regression analysis to model profitability and use the list of factors in Table 16.15 as the independent variables.

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TABLE 16.15: *Variables Considered*

Category	Name	Description
Competitive	PRICE	Room rate for the inn ($/night)
	RATE	Average competitive room rate ($/night)
	RMS1	Hotel rooms within 1 mile
	RMSTOTAL	Hotel rooms within 3 miles
	ROOMSINN	Rooms in La Quinta Inn
Demand generators	CIVILIAN	Civilian personnel on base
	COLLEGE	College enrollment
	HOSP1	Hospital beds within 1 mile
	HOSPTOTL	Hospital beds within 4 miles
	HVYIND	Heavy industrial employment
	LGTIND	Light industrial acreage
	MALLS	Shopping mall square footage
	MILITARY	Military personnel
	OFC1	Office space within 1 mile (in 000)
	OFCTOTAL	Office space within 4 miles (in 000)
	PASSENGR	Airport passengers enplaned daily
	RETAIL	Scale ranking of retail activity (0 poor, 10 excellent)
	TOURISTS	Annual tourists (in 000)
	TRAFFIC	Traffic count (traffic/hour)
	VAN	Airport van (1 yes, 0 no)
Demographic	EMPLYPCT	Unemployment percentage
	INCOME	Average family income
	POPULACE	Residential population
	STATE*	State population per inn
	URBAN*	Urban population per inn
Market awareness	AGE	Years inn has been open
	NEAREST	Distance to nearest La Quinta Inn
	CLOSEST	The inn number of the closest La Quinta Inn (data for inn numbers 1-56 is on the Student CD.)
Physical	ACCESS	Accessibility (0 poor, 10 excellent)
	ARTERY	Major traffic artery (1 yes, 0 no)
	DISTCBD	Distance to downtown (miles)
	SIGNVIS	Sign visibility (0 poor, 10 excellent)
Success measures	OCC_83	Occupancy rate in 1983 (percentage)
	OCC_86	Occupancy rate in 1986 (percentage)
	PROFIT_83	Profit in 1983 ($ in 000)
	PROFIT_86	Profit in 1986 ($ in 000)
	OP_M_83	Operating margin in 1983 (percentage)
	OP_M_86	Operating margin in 1986 (percentage)

*Variables not included in data set

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Determining the dependent variable seemed more difficult than determining the independent variables. Exactly what is the appropriate measure for a "good" hotel? After discussion with the site selection committee, three candidates emerged that seemed plausible.

1. *Occupancy*. Occupancy is the ratio of average rented rooms to total rooms. It is a widely used statistic in hotel administration.
2. *Profit*. The bookkeeping methods used allowed each inn to be a profit center, so profit data were available.
3. *Operating margin*. Operating margin is a percentage measure that consists of adding depreciation and interest expenses to the profit of an inn and dividing by the total revenue.

The economics of the preceding few years whipsawed the profitability of the hotel industry in oil-producing states. Due to the turbulent economic environment, the project developers decided to gather data for two different years: a good year, 1983, and a poor year, 1986. Because of the unprofitability of new inns and the expense of data gathering, data only were collected on a group of 56 mature inns. (Data can be found on the Student CD.)

Access your Student CD now for data for this LaQuinta Inns case.

Dallas Expansion

The first test of utilizing regression for location analysis was to determine an appropriate location for expansion in the Dallas market. The population and real estate prices in the Dallas area were increasing rapidly. Dallas was touted as one of the top cities in the nation in which to do business, and the northern suburb of Plano was considered a boomtown due to the surge in population and corporate headquarters. Twelve inns were already in place and doing well in the Dallas/Ft. Worth metroplex.

The six candidate sites for expansion in Dallas were as follows:

A. *Dallas—Downtown*. The corner of Houston and Young Streets, three blocks from the convention center and two blocks from the Trinity River.
B. *Dallas—Oak Lawn*. 3000 Oak Lawn Avenue, located in a large retail shopping area.
C. *Dallas—Fair Park*. 3500 Cullum Boulevard, across from Fair Park, a large complex that holds a football stadium (the Cotton Bowl), the Starplex Amphitheatre, various exposition halls, and hosts the state fair.
D. *Dallas—Southern Methodist University*. Near Mockingbird and McMillan Streets, one block from the eastern border of the Southern Methodist University campus.
E. *Coppell—DFW Airport*. 1000 Sandy Lake Road, on property currently owned by Marriott but not yet built on.

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F. *Plano—Legacy*. 5200 Legacy Drive in an area with a mostly finished office park near the offices of Electronic Data Systems, Texas Instruments, Raytheon, and other similar firms.

Purchase and development costs differ mildly for each of the potential sites. The data for each location are contained on the Student CD.

It was clear that the data from the 56 mature inns could be analyzed and put to use. What was not clear was the role any regression output should play. Should "gut feel" augment any regression model, or vice versa? Should the model be used to pick a site or just to eliminate poor choices? What were the strategic and tactical considerations that could not be modeled in a regression?

Questions:

- Which of the three success measures is appropriate? (Use both intuitive and data-driven arguments.)
- Are the variables considered (Table 16.16) appropriate for the decision at hand? What other variables might you want to consider?
- Determine appropriate predictors of operating margin through correlation and regression analysis. Comment on the variables both in and not in your predictive model.
- How should your model be used in site selection?
- Make recommendations concerning the Dallas expansion.