

PROBLEMS

Software, such as OM Explorer, Active Models, and POM for Windows, is available in myomlab. Check with your instructor on how best to use it. In many cases, the instructor wants you to understand how to do the calculations by hand. At most, the software provides a check on your calculations. When calculations are particularly complex and the goal is interpreting the results in making decisions, the software replaces entirely the manual calculations.

1. The owner of a computer store rents printers to some of her preferred customers. She is interested in arriving at a forecast of rentals so that she can order the correct quantities of supplies that go with the printers. Data for the last 10 weeks are shown here.

Week	Rentals	Week	Rentals
1	23	6	28
2	24	7	32
3	32	8	35
4	26	9	26
5	31	10	24

- a. Prepare a forecast for weeks 6 through 10 by using a five-week moving average. What is the forecast for week 11?
 - b. Calculate the mean absolute deviation as of the end of week 10.
2. Sales for the past 12 months at Dalworth Company are given here.

Month	Sales (\$ millions)	Month	Sales (\$millions)
January	20	July	53
February	24	August	62
March	27	September	54
April	31	October	36
May	37	November	32
June	47	December	29

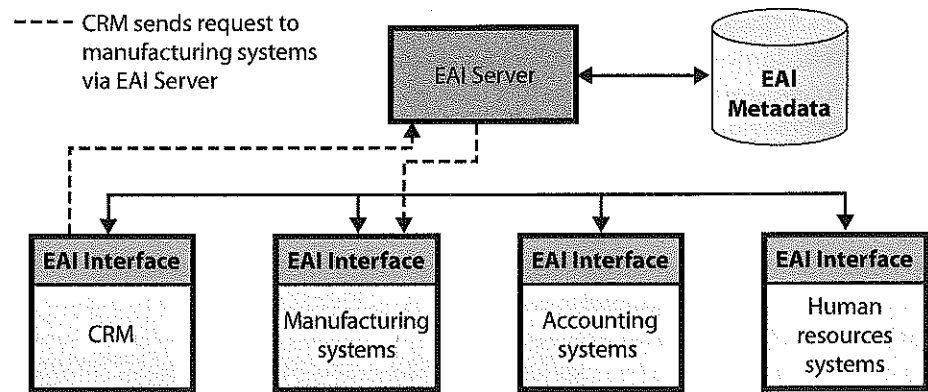
- a. Use a three-month moving average to forecast the sales for the months May through December.
- b. Use a four-month moving average to forecast the sales for the months May through December.
- c. Compare the performance of the two methods by using the mean absolute deviation as the performance criterion. Which method would you recommend?
- d. Compare the performance of the two methods by using the mean absolute percent error as the performance criterion. Which method would you recommend?
- e. Compare the performance of the two methods by using the mean squared error as the performance criterion. Which method would you recommend?

3. Karl's Copiers sells and repairs photocopy machines. The manager needs weekly forecasts of service calls so that he can schedule service personnel. Use the actual demand in the first period for the forecast for the first week so error measurement begins in the second week. The manager uses exponential smoothing with $\alpha = 0.20$. Forecast the number of calls for week 6, which is next week.

Week	Actual Service Calls
1	24
2	32
3	36
4	23
5	25

4. Consider the sales data for Dalworth Company given in Problem 2.
 - a. Use a three-month weighted moving average to forecast the sales for the months April through December. Use weights of (3/6), (2/6), and (1/6), giving more weight to more recent data.
 - b. Use exponential smoothing with $\alpha = 0.6$ to forecast the sales for the months April through December. Assume that the initial forecast for January was \$22 million. Start error measurement in April.
 - c. Compare the performance of the two methods by using the mean absolute deviation as the performance criterion, with error measurement beginning in April. Which method would you recommend?
 - d. Compare the performance of the two methods by using the mean absolute percent error as the performance criterion, with error measurement beginning in April. Which method would you recommend?
 - e. Compare the performance of the two methods by using the mean squared error as the performance criterion, with error measurement beginning in April. Which method would you recommend?
5. A convenience store recently started to carry a new brand of soft drink in its territory. Management is interested in estimating future sales volume to determine whether it should continue to carry the new brand or replace it with another brand. At the end of April, the average monthly sales volume of the new soft drink was 700 cans and the trend was +50 cans per month. The actual sales volume figures for May, June, and July are 760, 800, and 820, respectively. Use trend-adjusted exponential smoothing with $\alpha = 0.2$ and $\beta = 0.1$ to forecast usage for June, July, and August.
6. Community Federal Bank in Dothan, Alabama, recently installed a new automatic teller machine to perform the standard banking services and handle loan applications and investment transactions. The new machine is a bit complicated to use, so management is interested in

Figure 9-17
Design and Implementation for
the Five Components



The layers of EAI software shown in Figure 9-17 enable existing applications to communicate with each other and to share data. For example, EAI software can be configured to automatically carry out the data conversion required to make data compatible among different systems. When the CRM applications send data to the manufacturing application system, for example, the CRM system sends its data to an EAI software program. That EAI program makes the conversion and then sends the converted data to the ERP system. The reverse action is taken to send data back from the ERP to the CRM.

Although there is no centralized EAI database, the EAI software keeps files of metadata that describe data formats and locations. Users can access the EAI system to find the data they need. In some cases, the EAI system provides services that provide a “virtual integrated database” for the user to process.

The major benefit of EAI is that it enables organizations to use existing applications while eliminating many of the serious problems of isolated systems. Converting to an EAI system is not nearly as disruptive as converting to an ERP system, and it provides many of the benefits of ERP. Some organizations develop EAI applications as a stepping stone to complete ERP systems.

Q5

What Are the Elements of an ERP System?

Because of its importance to organizations today, we will consider ERP in more depth than CRM or EAI. To begin, the term *ERP* has been applied to a wide array of application solutions, in some cases erroneously. Some vendors attempted to catch the buzz for ERP by misapplying the term to applications that provided only one or two integrated functional applications.

The organization ERPsoftware360 publishes a wealth of information about ERP vendors, products, solutions, and applications. According to its Web site (www.erpsoftware360.com/erp-101.htm), for a product to be considered a true ERP product it must include applications that integrate:

- Supply chain (procurement, sales order processing, inventory management, supplier management, and related activities)
- Manufacturing (scheduling, capacity planning, quality control, bill of materials, and related activities)
- CRM (sales prospecting, customer management, marketing, customer support, call center support)
- Human resources (payroll, time and attendance, HR management, commission calculations, benefits administration, and related activities)
- Accounting (general ledger, accounts receivable, accounts payable, cash management, fixed asset accounting)

An ERP solution consists of application programs, databases, business process procedures, and training and consulting. We consider each, in turn.

ERP Application Programs

ERP vendors design application programs to be configurable so that development teams can alter them to meet an organization's requirements without changing program code. Accordingly, during the ERP development process, the development team sets configuration parameters that specify how ERP application programs will operate. For example, an hourly payroll application is configured to specify the number of hours in the standard workweek, hourly wages for different job categories, wage adjustments for overtime and holiday work, and so forth.

Of course, there are limits to how much configuration can be done. If a new ERP customer has requirements that cannot be met via program configuration, then it either needs to adapt its business to what the software can do or write (or pay another vendor to write) application code to meet its requirement. As stated in Chapter 6, such custom programming is expensive, both initially and in long-term maintenance costs. Thus, choosing an ERP solution that has applications that function close to the organization's requirements is critical to its successful implementation.

ERP Databases

An ERP solution includes a database design as well as initial configuration data. It does not, of course, contain the company's operational data. During development, the team must enter the initial values for that data as part of the development effort.

If your only experience with databases is creating a few tables in Microsoft Access, then you probably underestimate the value and importance of ERP database designs. SAP, the leading vendor of ERP solutions, provides ERP databases that contain over 15,000 tables. The design includes the metadata for those tables, as well as their relationships to each other, and rules and constraints about how the data in some tables must relate to data in other tables. The ERP solution also contains tables filled with initial configuration data.

Reflect on the difficulty of creating and validating data models (as discussed in Chapter 8), and you will have some idea of the amount of intellectual capital invested in a database design of 15,000 tables. Also, consider the magnitude of the task of filling such a database with users' data!

Although we did not discuss this database feature in Chapter 8, large organizational databases contain two types of program code. The first, called a **trigger**, is a computer program stored within the database that runs to keep the database consistent when certain conditions arise. The second, called a **stored procedure**, is a computer program stored in the database that is used to enforce business rules. An example of such a rule would be never to sell certain items at a discount. Triggers and stored procedures are also part of the ERP solution. Much of this program code needs to be configured during the ERP implementation as well.

Business Process Procedures

The third component of an ERP solution is a set of inherent procedures that implement standard business processes. ERP vendors develop hundreds, or even thousands, of procedures that enable the ERP customer organization to accomplish its work using the applications provided by the vendor. Figure 9-18 shows a part of the SAP ordering business process; this process implements a portion of the inbound logistics activities. Some ERP vendors call the inherent processes that are defined in the ERP solution **process blueprints**.

Without delving into the details, you should be able to understand the flow of work outlined in this process. Every function (rounded rectangles in Figure 9-18) consists of a set of procedures for accomplishing that function. Typically, these procedures require an ERP user to use application menus, screens, and reports to accomplish the activity.

As with application programs, ERP users must either adapt to the predefined, inherent processes and procedures or design new ones. In the latter case, the design of new procedures may necessitate changes to application programs and to database structures as well. Perhaps you can begin to understand why organizations attempt to conform to vendor standards.

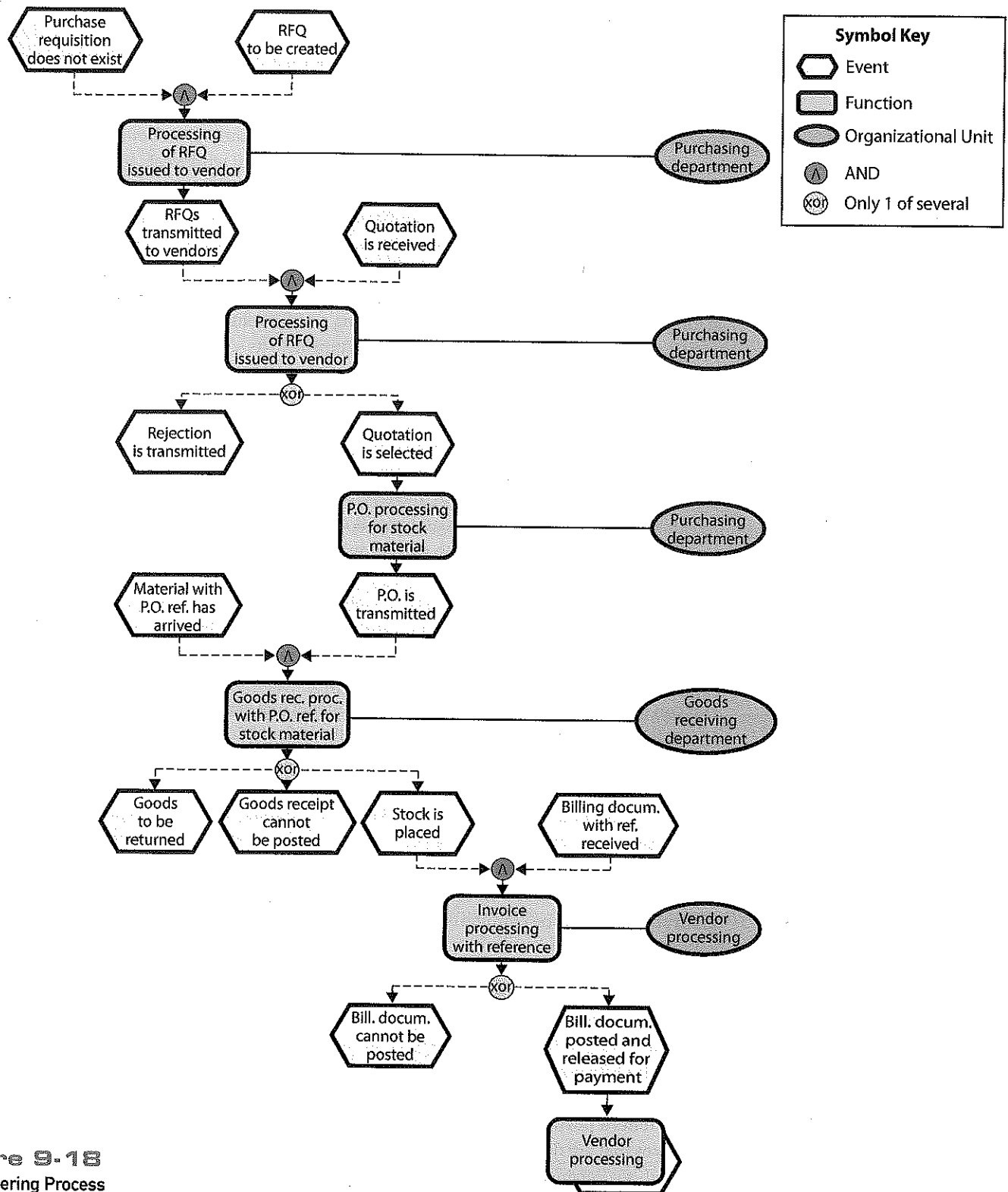


Figure 9-18
SAP Ordering Process

Source: Thomas A. Curran, Andrew Ladd, and Dennis Ladd, *SAP/R/3 Reporting Business and Intelligence*, 1st ed. copyright 2000. Reprinted by permission of Pearson Education, Inc., Upper Saddle River, NJ.

Training and Consulting

Because of the complexity and difficulty of implementing and using ERP solutions, ERP vendors have developed training curricula and classes. SAP operates universities, in which customers and potential customers receive training both before and after the ERP implementation. In addition, ERP vendors typically conduct classes on site. To reduce expenses, the vendors sometimes train the organization's employees, called Super Users, to become in-house trainers in training sessions called **train the trainer**.

ERP training falls into two broad categories. The first category is training about how to implement the ERP solution. This training includes topics such as obtaining top-level management support, preparing the organization for change, and dealing with the inevitable resistance that develops when people are asked to perform work in new ways. The second category is training on how to use the ERP application software; this training includes specific steps for using the ERP applications to accomplish the activities in processes such as those in Figure 9-18.

ERP vendors also provide on-site consulting for implementing and using the ERP system. Additionally, an industry of third-party ERP consultants has developed to support new ERP customers and implementations. These consultants provide knowledge gained through numerous ERP implementations. Such knowledge is valued because most organizations only go through an ERP conversion once. Ironically, having done so, they now know how to do it. Consequently, some employees, seasoned by an ERP conversion with their employer, leave that company to become ERP consultants.

Industry-Specific Solutions

As you can tell, considerable work needs to be done to customize an ERP application to a particular customer. To reduce that work, ERP vendors provide starter kits for specific industries called **industry-specific solutions**. These solutions contain program and database configuration files as well as process blueprints that apply to ERP implementations in specific industries. Over time, SAP, which first provided such solutions, and other ERP vendors created dozens of such starter kits for manufacturing, sales and distribution, healthcare and other major industries.

What Companies Are the Major ERP Vendors?

Although more than 100 different companies advertise ERP products, not all of those products meet the minimal ERP criteria. Even of those that do, the bulk of the market is held by the five vendors shown in Figure 9-19. This figure shows market rank rather than market share because it is difficult to obtain comparable revenue numbers. Both Epicor and Infor are owned by private equity investors and do not publish financial data. Their rankings are based on what little sales data is publicly available. Microsoft's ERP revenue is combined with its CRM revenue, and its true ERP revenue is unknown. Similarly, Oracle and SAP combine ERP revenue with revenue from other products.

Figure 9-19
SAP Characteristics of
Top ERP Vendors

Company	ERP Market Rank	Remarks	Future
Epicor	5	Strong industry-specific solutions, especially retail.	Epicor 9 designed for flexibility (SOA). Highly configurable ERP. Lower cost.
Microsoft Dynamics	4	Four products acquired: AX, Nav, GP, and Solomon. AX and Nav more comprehensive. Solomon on the way out? Large VAR channel.	Products not well integrated with Office. Not integrated at all with Microsoft development languages. Product direction uncertain. Watch for Microsoft ERP announcement on the cloud (Azure).
Infor	3	Privately held corporation that has acquired an ERP product named Baan, along with more than 20 others.	Span larger small companies to smaller large companies. Offers many solutions.
Oracle	2	Combination of in-house and acquired (PeopleSoft, Siebel) products.	Intensely competitive company with strong technology base. Large customer base. Flexible SOA architecture. Expensive. Oracle CEO Ellison owns 70% of NetSuite.
SAP	1	Led ERP success. Largest vendor, most comprehensive solution. Largest customers.	Technology older. Expensive and seriously challenged by less expensive alternatives. Huge customer base. Future growth uncertain.

Outsourcing

Vertical integration

Do or buy

Location

Long-term capacity
management

a particularly significant impact on the strategy of the organization, they set the context in which all other process design decisions are made. The three decisions are:

- 1 How should the network be configured? This means, first, how can an operation influence the shape which the network might take? Second, how much of the network should the operation own? This may be called the **outsourcing, vertical integration or do-or-buy** decision.
- 2 Where should each part of the network be located? If the homeware company builds a new factory, should it be close to its suppliers or close to its customers, or somewhere in between? This decision is called the operations **location** decision.
- 3 What physical capacity should each part of the network have? How large should the homeware factory be? Should it expand in large-capacity steps or small ones? These type of decisions are called **long-term capacity management** decisions.

Note that all three of these decisions rely on assumptions regarding the level of future demand. The supplement to this chapter explores forecasting in more detail. Also, we will cover the more operational day-to-day issues of managing operations networks. In this chapter we deal with these three related strategic decisions.

Configuring the supply network

Changing the shape of the supply network

Even when an operation does not directly own, or even control, other operations in its network, it may still wish to change the shape of the network. This involves attempting to manage network behaviour by reconfiguring the network so as to change the scope of the activities performed in each operation and the nature of the relationships between them. Reconfiguring a supply network sometimes involves parts of the operation being merged – not necessarily in the sense of a change of ownership of any parts of an operation, but rather in the way responsibility is allocated for carrying out activities. The most common example of network reconfiguration has come through the many companies that have recently reduced the number of direct suppliers. The complexity of dealing with many hundreds of suppliers may both be expensive for an operation and (sometimes more important) prevent the operation from developing a close relationship with a supplier. It is not easy to be close to hundreds of different suppliers.

Disintermediation

Disintermediation

Another trend in some supply networks is that of companies within a network bypassing customers or suppliers to make contact directly with customers' customers or suppliers' suppliers. 'Cutting out the middlemen' in this way is called **disintermediation**. An obvious example of this is the way the Internet has allowed some suppliers to 'disintermediate' traditional retailers in supplying goods and services to consumers. So, for example, many services in the travel industry that used to be sold through retail outlets (travel agents) are now also available direct from the suppliers. The option of purchasing the individual components of a vacation through the web sites of the airline, hotel, car hire company, etc., is now easier for consumers. Of course, they may still wish to purchase an 'assembled' product from retail travel agents which can have the advantage of convenience. Nevertheless the process of disintermediation has developed new linkages in the supply network.

Co-opetition

One approach to thinking about supply networks sees any business as being surrounded by four types of players: suppliers, customers, competitors and complementors. Complementors enable one's products or services to be valued more by customers because they can also have the

complementor's products or services, as opposed to when they have yours alone. Competitors are the opposite: they make customers value your product or service less when they can have their product or service, rather than yours alone. Competitors can also be complementors and vice versa. For example, adjacent restaurants may see themselves as competitors for customers' business. A customer standing outside and wanting a meal will choose between the two of them. Yet, in another way they are complementors. Would that customer have come to this part of town unless there was more than one restaurant to choose from? Restaurants, theatres, art galleries and tourist attractions generally, all cluster together in a form of cooperation to increase the total size of their joint market. It is important to distinguish between the way companies cooperate in increasing the total size of a market and the way in which they then compete for a share of that market. Customers and suppliers, it is argued, should have 'symmetric' roles. Harnessing the value of suppliers is just as important as listening to the needs of customers. Destroying value in a supplier in order to create it in a customer does not increase the value of the network as a whole. So, pressurizing suppliers will not necessarily add value. In the long term it creates value for the total network to find ways of increasing value for suppliers and well as customers. All the players in the network, whether they are customers, suppliers, competitors or complementors, can be both friends and enemies at different times. The term used to capture this idea is 'co-opetition'.²

Co-opetition

In-house or outsource? Do or buy? The vertical integration decision

No single business does everything that is required to produce its products and services. Bakers do not grow wheat or even mill it into flour. Banks do not usually do their own credit checking; they retain the services of specialist credit checking agencies that have the specialized information systems and expertise to do it better. This process is called 'outsourcing' and has become an important issue for most businesses. This is because, although most companies have always outsourced some of their activities, a larger proportion of direct activities are now being bought from suppliers. Also many indirect processes are now being outsourced. This is often referred to as 'business process outsourcing' (BPO). Financial service companies in particular are starting to outsource some of their more routine back-office processes. In a similar way many processes within the human resource function from simply payroll services through to more complex training and development processes, are being outsourced to specialist companies. The processes may still be physically located where they were before, but the staff and technology are managed by the outsourcing service provider. The reason for doing this is often primarily to reduce cost. However, there can sometimes also be significant gains in the quality and flexibility of service offered. *'People talk a lot about looking beyond cost cutting when it comes to outsourcing companies' human resource functions*, says Jim Madden, CEO of Exult, the California-based specialist outsourcing company, *'I don't believe any company will sign up for this [outsourcing] without cost reduction being part of it, but for the clients whose human resource functions we manage, such as BP, and Bank of America, it is not just about saving money.'*

The outsourcing debate is just part of a far larger issue which will shape the fundamental nature of any business. Namely, what should the scope of the business be? In other words, what should it do itself and what should it buy in? This is often referred to as the 'do-or-buy decision' when individual components or activities are being considered, or 'vertical integration' when it is the ownership of whole operations that is being decided. Vertical integration is the extent to which an organization owns the network of which it is a part. It usually involves an organization assessing the wisdom of acquiring suppliers or customers. Vertical integration can be defined in terms of three factors.³

- 1 *The direction of vertical integration.* Should an operation expand by buying one of its suppliers or by buying one of its customers? The strategy of expanding on the supply side of the network is sometimes called 'backward' or 'upstream' vertical integration,

and expanding on the demand side is sometimes called 'forward' or 'downstream' vertical integration.

- 2 *The extent of vertical integration.* How far should an operation take the extent of its vertical integration? Some organizations deliberately choose not to integrate far, if at all, from their original part of the network. Alternatively, some organizations choose to become very vertically integrated.
- 3 *The balance among stages.* How exclusive should the relationship be between operations. A totally balanced network relationship is one where one operation produces only for the next stage in the network and totally satisfies its requirements. Less than full balance allows each operation to sell its output to other companies or to buy in some of its supplies from other companies.

Making the outsourcing / vertical integration decision

Whether it is referred to as do-or-buy, vertical integration or no vertical integration, in-house or outsourced supply, the choice facing operations is rarely simple. Organizations in different circumstances with different objectives are likely to take different decisions. Yet the question itself is relatively simple, even if the decision itself is not: 'Does in-house or outsourced supply in a particular set of circumstances give the appropriate performance objectives that it requires to compete more effectively in its markets?' For example, if the main performance objectives for an operation are dependable delivery and meeting short-term changes in customers' delivery requirements, the key question should be: 'How does in-house or outsourcing give better dependability and delivery flexibility performance?' This means judging two sets of opposing factors – those which give the potential to improve performance and those which work against this potential being realized. Table 1.1 summarizes some arguments for in-house supply and outsourcing in terms of each performance objective.

Table 1.1 How in-house and outsourced supply may affect an operation's performance objectives

Performance objective	'Do it yourself' in-house supply	'Buy it in' outsourced supply
Quality	The origins of any quality problems are usually easier to trace in-house and improvement can be more immediate but there can be some risk of complacency.	Supplier may have specialized knowledge and more experience, also may be motivated through market pressures, but communication more difficult.
Speed	Can mean synchronized schedules which speeds throughput of materials and information, but if the operation has external customers, internal customers may be low-priority.	Speed of response can be built into the supply contract where commercial pressures will encourage good performance, but there may be significant transport/delivery delays.
Dependability	Easier communications can help dependability, but, if the operation also has external customers, internal customers may receive low priority.	Late-delivery penalties in the supply contract can encourage good delivery performance, but organizational barriers may inhibit in communication.
Flexibility	Closeness to the real needs of a business can alert the in-house operation to required changes, but the ability to respond may be limited by the scale and scope of internal operations.	Outsource suppliers may be larger with wider capabilities than in-house suppliers and have more ability to respond to changes, but may have to balance conflicting needs of different customers.
Cost	In-house operations do not have to make the margin required by outside suppliers so the business can capture the profits which would otherwise be given to the supplier, but relatively low volumes may mean that it is difficult to gain economies of scale or the benefits of process innovation.	Probably the main reason why outsourcing is so popular. Outsourced companies can achieve economies of scale and they are motivated to reduce their own costs because it directly impacts on their profits, but costs of communication and coordination with supplier need to be taken into account.

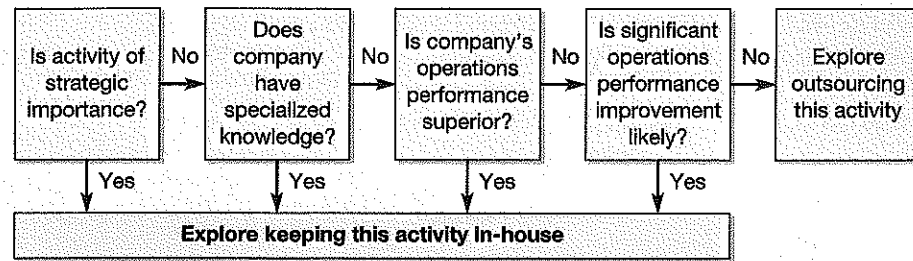


Figure 1.3 The decision logic of outsourcing

Deciding whether to outsource

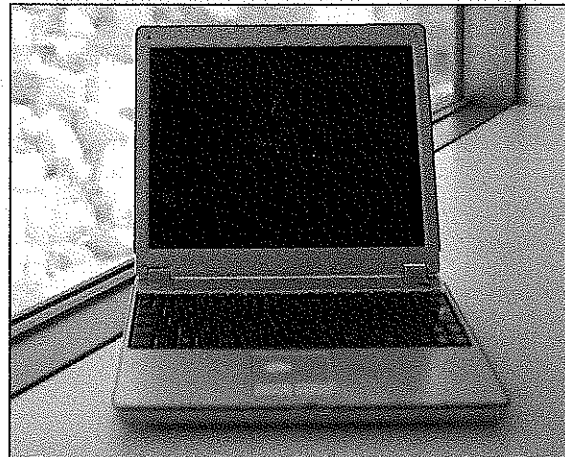
Outsourcing is a strategic decision

Although the effect of outsourcing on the operation's performance objective is important, there are other factors that companies take into account when deciding if outsourcing an activity is a sensible option. For example, if an activity has long-term **strategic importance** to a company, it is unlikely to outsource it. For example, a retailer might choose to keep the design and development of its web site in-house even though specialists could perform the activity at less cost because it plans to move into web-based retailing at some point in the future. Nor would a company usually outsource an activity where it had specialized skills or knowledge. For example, a company making laser printers may have built up specialized knowledge in the production of sophisticated laser drives. This capability may allow it to introduce product or process innovations in the future. It would be foolish to 'give away' such capability. After these two more strategic factors have been considered the company's operations performance can be taken into account. Obviously if its operations performance is already too superior to any potential supplier, it would be unlikely to outsource the activity. But also even if its performance was currently below that of potential suppliers, it may not outsource the activity if it feels that it could significantly improve its performance. Figure 1.3 illustrates this decision logic.

Short case

Behind the brand names⁴

The market for notebook computers is a fast-evolving and competitive one. Brands such as Dell, Sony, Fujitsu and Apple as well as many smaller brands vie for customers' attention. Yet few who buy these products know that the majority of the world's notebooks, including most of those sold by the big names, are made by a small number of Taiwanese and Korean manufacturers. Taiwanese firms alone make around 60 per cent of all notebooks in the world, including most of Dell, Compaq and Apple machines. And this group of Taiwanese manufacturers is dominated by Hon Hai, Quanta and Compal. In a market with unremitting technological innovation and fierce price competition, it makes sense to outsource production to companies that can achieve the economies that come with high-volume manufacture as well develop the expertise which enables new designs to be put into production without the cost overruns and delays which could ruin a new product launch. However, the big brand names are keen to defend their products' performance. Dell, for example, admits that a major driver of its outsourcing



Source: Rex Features

policy is the requirement to keep costs at a competitive level, but says that it can ensure product quality and performance through its relationship with its suppliers. 'The production lines are set up by Dell and managed by Dell', says Tony Bonadero, Director of Product Marketing for Dell's laptop range. Dell also imposes strict quality control and manages the overall design of the product.