

ANSWERS TO TRY IT YOURSELF QUESTIONS

CHAPTER 1

1. Use the transformation model (Figure 1.1) to analyse the following types of organization. In each case, list the transformed resources, the transforming resources and the outputs produced.

- a) Clothing manufacturer
- b) School
- c) Dentist
- d) Accountancy
- e) Restaurant
- f) Bank

Operation	Transformed resources	Transforming resources	Outputs
Clothing manufacturer	Rolls of cloth, thread, etc.	Sewing machines, etc. Workers	Finished garments
School	Pupils	Teachers Books Classrooms and school equipment	Educated pupils
Dentist	Patients requiring treatment (e.g. for toothache)	Dentist Dentist chair and other equipment	Treated patients (e.g. with no toothache)
Accountancy	Financial data	Accountants Computers with accounting software	Financial information (e.g. set of accounts)
Restaurant	Hungry customers	Waiting staff Tables, chairs, etc.	Full customers
	Uncooked food	Kitchen staff Ovens, etc.	Prepared food
Bank	Customers (with financial needs)	Banking hall Banking staff	Customers with their financial needs

		Computers Telephone Website	satisfied
	Financial information	Banking staff Computers	Financial services

2. What are the main differences between manufacturing and service operations?

Services are generally distinguished by:

Tangibility: Goods are physical entities that can be touched, stored and transported. Most services are intangible and likely to possess these properties to a much lesser extent, if at all.

Simultaneity: The production and consumption of a service usually takes place at the same time. So, customers usually have to be present to receive the service when it is produced.

Customer contact: Services normally require some degree of contact between the customer and the service operation.

Quality: In services, quality is typically dependent on the perception of the customer, which makes it difficult to define and measure.

3. Think of five services that you have experienced as a consumer in the last month (e.g. restaurant meal, transportation system, hairdresser, university class, cinema). Describe the degree of tangibility, simultaneity and customer contact you experienced with the service in each case. How did these affect your perception of the quality of the experience?

Clearly, your answers will depend upon the experiences cited. As an example, the issues associated with a restaurant meal might include the following. The experience of eating at a restaurant includes a mixture of the tangible (the food and drink) and the intangible (the service received from table staff, the atmosphere in the restaurant, including other diners being served, and the conviviality of one’s dining companions). Whilst the food must be produced before consumption (but hopefully not too long before), all the intangible elements are entirely simultaneous in nature. Assuming that this is a table service restaurant, then there will be a reasonable degree of customer contact in the service, including checking in, placing the

order, being served, clearing the table, paying the bill, and so on. All of these factors will affect the perception of quality experienced.

4. Explain, for the benefit of a friend who is not studying the subject, why operations management is vitally important for any organization.

Operations management is concerned with those activities that produce the goods and/or deliver the services required by customers. Without an operations function, nothing would get done in an organization. As such, its activities are at the very core of any organization. They typically involve the management of the vast majority of an organization's assets, employees and expenditure. Operations management is vitally important to the success of any organization because of its impact on the costs, quality, availability, timeliness and reliability of the goods and services produced.

5. What are the most important forces of globalization?

The most important forces of globalization are:

Technological

- The Internet and its associated information and communication technologies (ICTs).
- Improvements in transportation technology for goods and people.

Political

- International agencies that promote international trade and development, such as the WTO, the IMF and the World Bank.
- Regional trading groups, such as the EU, ASEAN and NAFTA.
- The fall of communism in Europe and the break-up of the Soviet Union.
- The change to a market-orientated economy in China and entry to the WTO.

Economic

- A sustained period of economic growth in the world economy, particularly the USA.

- The emergence of new manufacturing centers in the NIEs of the 'Tiger' economies of Asia (e.g. South Korea, Taiwan, Singapore, Hong Kong (China), Malaysia, Thailand, Philippines, Indonesia) and of Latin America (e.g. Brazil and Mexico).
- The growth in international trade in services, particularly benefiting India.
- The role of MNEs, which can be as economically powerful as some national governments.

Sociocultural factors

- The increase in the movement of people around the world, facilitated by more open borders and cheaper travel costs.
- People's aspirations to access the same products and services wherever they are in the world.

6. What are the main theories covering the internationalization of organizations?

The main theories of the internationalization of organizations are:

- Vernon's product cycle theory
- Dunning's eclectic theory
- Stage theories (including the Uppsala model and Ohmae's).

None of these offer entirely satisfactory explanations of the internationalization process.

7. Find a recent example from the business news media of an organization that operates internationally.

- Identify the most significant challenges it faces in its international operations management.**
- Identify the main benefits available to it from its international operations.**

Your answers will likely depend on current 'hot topics' at the time of writing. The following are generic points:

- The most significant challenge of operating internationally is encapsulated by the call to 'think global but act local'. This requires organizations to reconcile the conflicting demands globally and locally. Globally there is a pressure to maximize efficiency by standardizing operations for easier coordination and control. Locally there is a pressure to customize operations to meet the specific

requirements of each location, which can lead to a fragmentation of operations. Successful international operations management requires that these conflicting pressures be balanced.

- b) The main benefits of operating internationally are that organizations can share the learning gained from their own experiences and from the practices of other organizations that they come into contact with in other countries.

8. To what extent do you think that the internationalization of services should be treated as a special case from that of manufacturing?

Most theories about internationalization are implicitly, if not explicitly, based only on a consideration of manufacturing organizations. However, service operations can differ from manufacturing on the dimensions of tangibility, simultaneity, customer contact and quality. Services are generally considered to be more difficult to globalize because of the pressure to customize to meet different local needs. This pressure can be particularly acute in front office services due to the direct customer contact involved. In this respect, many services are fundamentally different to manufacturing and, thus, many people believe they ought to prompt a different consideration of the internationalization process.

9. Choose one of the major MNEs. Identify the most significant forces of globalization that have impacted on the international operations of the company in the last few years. What has been the organization's response to those forces?

Your answer will depend upon the organization chosen, but will be based on an assessment of the impact of the key forces of globalization (political, economic, sociocultural and, especially, technological).

10. Choose two companies that have internationalized in recent years, one manufacturer and one service provider. Which of the theories of internationalization best describes the way that each underwent internationalization?

Your answers will depend upon the organizations chosen, but should include a consideration of the main theories of internationalization (i.e. Vernon's product cycle theory, Dunning's eclectic theory and stage theories).

CHAPTER 2

1. Why is performance measurement important in operations management?

Performance measurement is important to operations management because it provides measures of organizational performance that can be used to guide decision-making and actions. Performance measurement is important because of the maxim, 'what gets measured gets done'. That is, the measures themselves act as a powerful signal to all organizational members about what aspects of performance are considered important. Thus, performance measures become the focus of actions throughout the organization. Performance measurement is also important strategically because it links operations and strategy together. Operations management is the means by which intentions are converted into actions. If strategic objectives can be articulated by the setting of appropriate performance targets, performance measurement becomes the means by which progress towards those objectives can be assessed.

2. What operations performance objectives would you expect the following organizations to give priority to?

- a) Ryanair (the budget airline)
- b) McDonald's (the fast-food chain)
- c) UPS (the parcel delivery company)
- d) Rolex (the watch manufacturer)
- e) Dell (the computer company)
- f) An emergency ambulance service

Using Nigel Slack's five performance objectives (cost, quality, speed, dependability and flexibility), arguably, you would expect the following:

Organization	Performance objectives	
	Most important	Also important
Ryanair	Cost	Dependability
McDonald's	Dependability	Cost

UPS	Speed	Dependability
Rolex	Quality	Flexibility
Dell	Flexibility	Cost, quality
Emergency ambulance service	Speed	Flexibility

3. List as many examples as you can of unanticipated (or even perverse) outcomes that have been the result of organizations changing their performance measures.

You may be able to find recent examples in the business press or from your own experiences. One example might be that of call centers that monitor their performance using measures of efficiency only (e.g. speed of answering the phone, number of calls answered per hour), which leave callers feeling hurried and dissatisfied with the quality of the response they get.

4. Why are the measures traditionally used to assess the performance of many operations (e.g. unit costs of production, labour productivity, machine utilization, output volumes) now considered to be inadequate?

The measures traditionally used in operations tend to focus almost exclusively on efficiency. They mostly ignore measures of effectiveness, thereby failing to place sufficient emphasis on satisfying customers.

Traditional measures of efficiency have been criticized (Neely *et al.*, 1995) as:

- Encouraging short-termism
- Lacking strategic focus
- Encouraging local optimization
- Encouraging managers to minimize any variances from standards rather than seeking continuous improvement
- Failing to provide information on what customers wanted and what their competitors were doing.

If competitiveness is not to be damaged, a range of measures that judge performance against a wider set of criteria are needed. In particular, more customer-based measures are needed. This is predominantly so in service operations which have become more important in advanced economies.

5. Suggest suitable measures of economy, efficiency and effectiveness that might be used to assess the performance of the operations in the following organizations:

- a. A budget fast-food outlet
- b. A computer manufacturer
- c. A management consultancy
- d. A theme park

There are many possibilities in each case. These might include:

Organization	Measure		
	<i>Economy</i>	<i>Efficiency</i>	<i>Effectiveness</i>
<i>Budget fast-food outlet</i>	Cost of ingredients Labour costs	Number of meals served per hour Customers served per employee	Customer satisfaction Percentage of returning customers
<i>Computer manufacturer</i>	Cost of components Labour costs	Unit cost of manufacture Output per employee	Number of returns Number of calls to customer helpline
<i>Management consultancy</i>	Labour costs Travel & subsistence costs	Number of bookable hours to client	Percentage of repeat business Recommendations per client
<i>Theme park</i>	Labour costs Energy costs	Number of visitors per day Ratio of customers to employees	Percentage of customers who would return Percentage of customers who would recommend to a friend

6. A furniture manufacturing company installed a new leg-forming machine at the end of 2014. The company has supplied the following financial data for 2014 and 2015 (all in £):

Criteria	2015	2014
Sales value	10,000,000	9,500,000
Labour costs	4,000,000	4,750,000
Raw material costs	3,000,000	2,900,000

Capital equipment depreciation	1,500,000	1,000,000
Other costs	500,000	500,000

Compare the labour, material and total productivity for 2015 and 2014. What might explain any differences?

Labour productivity = output / cost of hours worked during production

Material productivity = output / cost of raw materials and supplies used in production

Total factor productivity = output value / total value of all resources used in production

	2015	2014
Labour productivity	2.50	2.00
Material productivity	3.33	3.28
Total factor productivity	1.11	1.04

7. Use the balanced scorecard to suggest a set of performance measures for the following types of organization:

- a. A manufacturer of domestic appliances
- b. A hospital
- c. An airline
- d. A university

There are many possibilities in each case. These might include:

Organization	Perspective			
	Financial perspective	Customer	Internal business	Innovation and learning
Domestic appliance manufacturer	Profit Sales income	Customer satisfaction Percentage sales from new products	Output Unit cost of manufacture	New products launched per year
Hospital	Variance from budget	Patient satisfaction	Number of patients treated	Number of new treatments

		Patient recovery times	Cost of treating each patient	developed
<i>Airline</i>	Profit Sales income	Percentage of flights on time Number of frequent flyers	Number of passenger miles Seats occupied per flight	Number of employee suggestions
<i>University</i>	Variance from budget	Student satisfaction Percentage of students finding employment	Number of students Costs per students	Number of new courses developed

8. Using each of the performance measures you listed in answer to question 7, suggest an appropriate performance standard.

There are many potential performance standards that might be suggested. In each case, you should consider the bases for such standards which might be:

Internal:

- (a) the organization's past performance
- (b) the organization's own targets

or

External:

- (a) competitors' performance
- (b) best practice
- (c) market requirements.

9. What are the benefits and difficulties associated with the different types of benchmarking?

There are three main approaches to benchmarking:

- *Internal benchmarking* is comparing practice and performance in one of an organization's locations to that in another. The benefit of this approach is that information about these operations should be readily available and reliable. Similarly, it should be fairly easy to gain access to the organization's other facilities in order to study the practices. The main difficulty associated with internal benchmarking is

that it is limited, as even the best level of internal performance may be much worse than that achieved externally.

- *Competitive benchmarking* is comparing the organization's practices and performance with those of direct competitors. The main advantage is that it can enable competitive deficiencies to be identified and addressed. The main difficulty is that although competitors are easy to identify, they may not be willing to divulge relevant information to a direct competitor to learn from them, as this might endanger their competitive advantage.
- *Best practice benchmarking* is comparing the organization's practices and performance with a similar operation in an organization thought to be exhibiting best practice. The idea is to learn from world-class performers wherever they are found. This has two main advantages. Firstly, studying organizations in different industries can encourage innovative thinking. Secondly, organizations that are not direct competitors may be more willing to divulge information. The disadvantage is that it may be difficult to know exactly where best practice for a particular operation is to be found. Also, it may prove difficult to apply their working methods in a very different industry.

10. Choose a well-known organization (or one that you know well). Which other organizations should they choose for competitive and best practice benchmarking? What performance measures should they use, and why?

Your answer will depend on the organization chosen. You may find it useful to review these two aspects of benchmarking by returning to pages 54-56 in the book.

11. Visit the website of a well-known organization and view the contents of its corporate social responsibility pages (assuming that it has them). To what extent does this give you confidence that the organization would score highly on the social and environmental dimensions of the triple bottom line?

Your answer will depend on the organization chosen. Of particular interest will be the level of detail provided on this subject by the organization and what (if any) performance measures, targets and standards it has chosen to adopt and use, and whether it is using externally recognized standards such as ISO 14000.

CHAPTER 3

1. Why are an organization's operations crucial to its strategic success?

A business strategy is a long-term plan or set of intentions which set the long-term direction of the organization. An organization's operations are strategically important because the operations function is where most organizational activity takes place. Organizational strategy will only become a meaningful reality, in practice, if operational level activities are consistent with long-term strategic intentions. It is the myriad of daily actions of operations, when considered in their totality, that constitute the organization's long-term strategic direction.

2. How can an organization use its operations as a 'formidable competitive weapon'?

The concept of operations acting as a 'formidable competitive weapon' was first expounded by Wickham Skinner. He argued that an organization's operations could provide a source of competitive advantage if they were allowed to play a full strategic role in the organization. That this was not the case in some organizations was due to there being inappropriate expectations of and attitudes towards operations. He argued that it was necessary to identify a 'task' (i.e. a clear and unambiguous objective) for an organization's operations to pursue. This task should be determined logically from the organization's business strategy. This concept is in line with stage 3 in the Hayes and Wheelwright four-stage model. However, Hayes and Wheelwright go further in their description of a stage 4 organization. A stage 4 organization is one in which business strategy is driven from its operations excellence. The operations of a stage 4 organization provide the basis of a competitive advantage as they set industry standards in ways that delight customers. Thus, the organization's operations enable it to retain its existing customers and attract new ones. For such an operations-based competitive advantage to be sustainable, the organization must continue to develop its operations, as any source of advantage is liable to be imitated by competitors. To remain at stage 4, an organization needs to learn how to make the most of its existing resources and competences to learn how to develop new capabilities. Such ideas are very much aligned with the current theories of path dependency, dynamic capabilities and organizational learning that currently dominate research in strategic management.

3. Explain how the following types of organization might use their operations to gain a competitive advantage (like a Hayes and Wheelwright stage 4 organization):

- a. An airline
- b. A hospital
- c. A university
- d. A domestic appliances manufacturer

A stage 4 organization uses its operations excellence as the basis of its business strategy. Gaining a competitive advantage means outperforming rivals in ways valued by customers. This will involve some combination of cost, quality, speed, dependability and flexibility. Your answer must demonstrate how the organization might do this. In the case of an airline, you might point to the low-cost airlines such as EasyJet or Ryanair, whose success relies primarily on being able to offer low prices. It is their operational excellence in driving down their operating costs that largely underpins their business models. However, other airlines aim to gain a competitive advantage from the quality of their service, their reliability, and so on. Their business models can also be successful but their operations task is very different from their low-cost rivals.

4. Choose a well-known organization (or one for which you can easily access relevant information).

- a. Identify its business objectives and strategy (perhaps as stated in its mission statement).
- b. Identify its operations strategy by analysing its actions in the key decision areas of structure and infrastructure.
- c. Identify its operations performance objectives. You may need to infer these by assessing its performance in the five operations performance objectives (e.g. cost, quality, speed, dependability, flexibility).
- d. Compare its business objectives and strategy with its operations objectives and strategy using Hayes *et al.*'s criteria of consistency and contribution.
- e. Classify the organization in terms of the Hayes and Wheelwright four-stage model of strategic role of operations.

Your answer will depend upon the organization chosen. To revise the key decision areas of structure and infrastructure, see pages 83-84 in the book. For a reminder of the criteria from Hayes *et al.* (2005), go to pages 74-75. To view the Hayes and Wheelwright four-stage model, see Table 3.2 on page 75.

5. How can an international operations strategy be a source of competitive advantage?

Operating internationally can provide sources of competitive advantage from:

- *Global Sourcing*: facilitating access to the lowest-cost inputs and the most sophisticated products and services from the best suppliers.
- *Location*: locating facilities near to customers increases responsiveness and makes customization easier; concentrating operations at dedicated facilities enables economies of scale and scope.
- *Network Effects*: supply networks can be configured to maximize synergies to better serve customers (e.g. with lower cost, improved speed, dependability, etc.); focusing supply networks on customers can maximize organizational learning about and for customers to provide an advantage based on superior knowledge.
- *Competition*: exposure to international competition spurs improvements in operations and improves strategic understanding of markets and competitors.

6. Outline the main implications for operations for each of the four different modes of entry into foreign markets (direct export, joint venture, establishing a sales subsidiary, establishing a production facility).

With *direct export* the producer exports directly to customers in the new country, usually from a production facility in the producer's home country, which is bound to increase the complexity of managing that facility. The resulting arm's-length nature of the relationship with customers increases the likelihood of communication problems between the producer and the customer. There may also be problems with quality, especially where standards are difficult to define or subjective in nature. For manufacturers, delivery may be problematic if goods have to be transported long distances. There is also the potential for delays to occur at international borders. Whilst some services (e.g. back office and separated services) can be delivered using this mode, the risk of communication problems remains.

With a *joint venture* the organization sets up some kind of joint operation with a local partner. This might involve the local partner contributing to any one of a number of different activities, including distribution, design, full or partial manufacture of goods or delivery of services. The exact nature of any joint venture determines which aspects of operations need particular attention. The main issue for any organization entering a new country via a joint venture is the extent to which it relies on its partner for much of the

provision and interpretation of information from the country. Thus, the choice of partner is crucial and much effort is likely to be required to build good working relationships and to avoid misunderstandings.

Establishing a sales subsidiary usually involves the direct employment of staff in a foreign country, which raises a number of human resource management issues. One key issue is the extent to which expatriates or local staff should be employed. Employing local people can overcome some of the communication problems inherent in direct exporting and the problems of working with a joint venture partner. However, it does place a considerable burden on them being able to correctly interpret customer requirements. On the other hand, employees engaged locally may not have a full understanding of the parent organization and the working practices and culture of the home country.

Establishing a production facility is likely to involve significant foreign direct investment and requires a wide range of operations management expertise. This may include arranging for the employment of local staff, the supply of other resource inputs, logistics to ensure that products reach the local customers in such a way as to satisfy their needs, design and development in order to modify products and services to meet local requirements, and after-sales service operations for local customers.

7. Assess the operations management implications of internationalization for the following types of organization:

- a. A motor car manufacturer
- b. A manufacturer of fashionable clothing
- c. An insurance company
- d. A chain of fast-food outlets

The transformation model depicted in Figure 3.2 can provide a useful framework for analysing these examples.

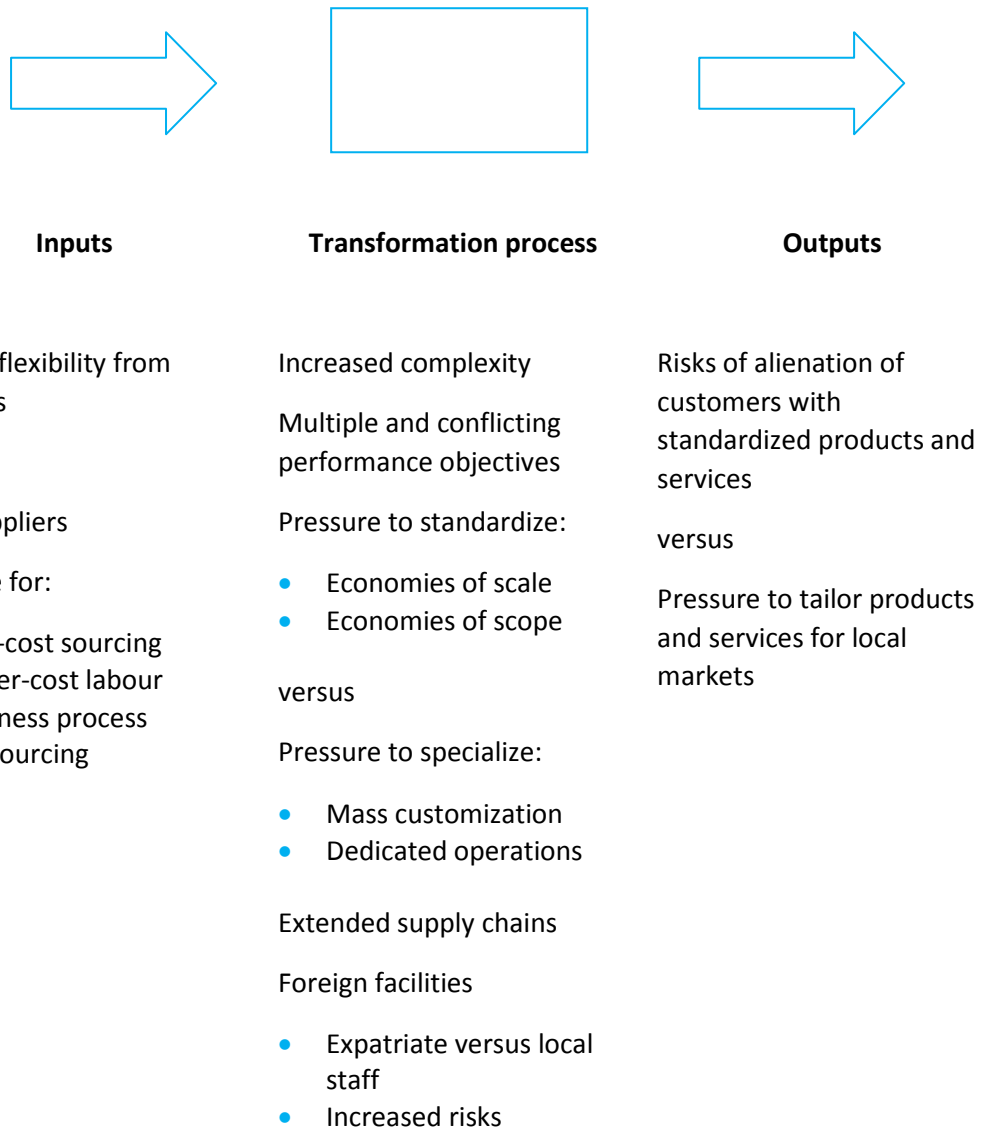


Figure 3.2 Implications of internationalization on operations

For example, in the case of (a) *A motor car manufacturer*, internationalization would imply for:

Outputs: The economics of motor car manufacturing creates great pressure to standardize products.

However, although there is some evidence of converging tastes for vehicles across the world, significant variations persist, not helped by different legislative and regularity requirements in different parts of the

world. Although some car manufacturers have tried to design world vehicles, they have mostly compromised on design aimed at the large regional markets (e.g. North America, Europe and East Asia). For a previously domestic manufacturer, internationalization usually means having to increase product variety due to a requirement to tailor products to different markets.

Process: Existing process technology for motor car manufacturing means production plants are usually dedicated to a single product within a mass manufacturing process. This means that volumes need to be maximized at any facility in order to achieve economies of scale. These factors create intensive pressures to standardize the product being made at any one facility. Although production facilities are often located to serve a specific regional market, products may need different versions to meet the needs of national markets. This increases the complexity of operations and can lead to multiple and conflicting performance objectives at individual plants.

Inputs: Production facilities could be located to access supplies of low-cost labour, land and other input resources. Internationalization would also provide access to non-domestic suppliers who might offer lower prices and/or superior products and capabilities. However, existing suppliers would need to be more flexible if they are to meet the more complex needs of an increased number of geographically dispersed production facilities.

Similar analyses can be conducted for the other examples, taking into account the specific factors affecting each of the respective industries.

8. What are the advantages and disadvantages for a US company in offshoring:

- a. its manufacturing operations to China; and
- b. its customer service telephone helpline to India?

For US companies, offshoring manufacturing to China is likely to be motivated by a resource-seeking strategy, and one initially seeking to reduce labour costs. Offshore facilities in China might also be used as a market access strategy to the world's most populous country. China seems an attractive manufacturing location, particularly in labour-intensive operations. However, initial set-up costs might be high and, depending on the markets intended to be served, transport costs seem likely to increase. There might also be quality problems. Offshoring to such a distant country is bound to increase the complexity of managing operations (e.g. in planning and control) and might reduce speed, dependability and flexibility.

India has proven an attractive destination for US companies offshoring separated services such as customer service telephone helplines. It is a resource-seeking strategy aimed at accessing well-educated low-cost labour. Telephone support services seem particularly appropriate due to India's good ICT links and its many English-speaking citizens. However, there have been problems due to differences in the English used in the two countries; not only in pronunciation but in the nuances and culturally specific references used in everyday parlance. This has led to frustrations in both parties, which has led to customer dissatisfaction in the USA and high staff turnover in the Indian call centres. Thus, whilst cost might be reduced (but maybe not by as much as envisaged), this might ultimately lead to a loss in revenue.

CHAPTER 4

1. Why are decisions about operations facilities so important?

Facilities decisions are important because they typically involve large capital investments. Once made, these decisions are not easily or cheaply undone, as they typically determine the organization's resources and capabilities for many years to come. As well as deciding where to locate particular facilities, facilities decisions involve determining the relationships between operations at different locations. Operations managers need to decide which facilities in which countries will produce each product or service and which customers or markets each facility will serve. Facilities decisions can be complex and strategic in scope and implication.

2. What are likely to be the most important factors in deciding where to locate the facilities for the following types of businesses?

- a. A car manufacturer
- b. A fast-food restaurant
- c. A designer of fashion clothing
- d. A research laboratory

Using MacCarthy and Atthirawong's factors (Table 4.1), in descending order of importance are likely to be the following (although these might well vary depending upon the organization and its objectives):

- a. *A car manufacturer*: Costs, infrastructure, economic factors, government and political factors, proximity to markets/customers.
- b. *A fast-food restaurant*: Proximity to markets/customers, proximity to competition, characteristics of a specific location, social and cultural factors.
- c. *A designer of fashion clothing*: Labour characteristics, quality of life, proximity to competition.
- d. *A research laboratory*: Labour characteristics, quality of life, costs, government and political factors.

3. A retailer is considering where to locate its new megastore. The company’s management group working on the project has drawn up the following table to show its scores against selected criteria for each of the three possible locations.

Criteria	Criteria weighting	Location		
		A	B	C
Population density	5	8	7	5
Site access	3	6	8	5
Parking area	3	5	7	9
Cost of land and buildings	2	6	5	8
Operating costs	2	6	7	7
Availability of labour	1	5	7	8

Which location should the company choose?

Using the weighted scoring method, each location scores as follows:

$$\text{Location A} = (5 \times 8) + (3 \times 6) + (3 \times 5) + (2 \times 6) + (2 \times 6) + (1 \times 5) = 102$$

$$\text{Location B} = (5 \times 7) + (3 \times 8) + (3 \times 7) + (2 \times 5) + (2 \times 7) + (1 \times 7) = 111$$

$$\text{Location C} = (5 \times 5) + (3 \times 5) + (3 \times 9) + (2 \times 8) + (2 \times 7) + (1 \times 8) = 105$$

Location B has the highest score (111), and so would be the favoured location using this method.

4. A vegetable packer has decided to set up a new plant to process its products, which it collects from local farms. It wants to know the best location for the packing plant. The locations of the farms and the weights of vegetables collected at each are shown in the table.

Farm	Map reference of location (x,y)	Weights of vegetables collected (100,000 kg per year)
Giles	24,33	139

George	50,60	45
Greenfields	23,96	78
Glebe	94,60	135

Calculate the coordinates of the optimal location for the packing plant.

$$\bar{x} = \frac{\sum x_i W_i}{\sum W_i} = \frac{(24 \times 139) + (50 \times 45) + (23 \times 78) + (94 \times 135)}{139 + 45 + 78 + 135} = \frac{20070}{397} = 50.55$$

$$\bar{y} = \frac{\sum y_i W_i}{\sum W_i} = \frac{(33 \times 139) + (60 \times 45) + (96 \times 78) + (60 \times 135)}{139 + 45 + 78 + 135} = \frac{22875}{397} = 57.62$$

So, the optimal location for the packaging plant that would result in the lowest transportation costs would be (50.55, 57.62). However, managers would also wish to consider other qualitative factors, and the extent to which the weights of vegetables currently collected from each farm were likely to continue into the future.

5. Use Meijboom and Houtepen's six factors to assess whether the following types of service organizations would be best advised to use a single centralized facility or a series of localized facilities for their operations:

- a. A book seller
- b. A consumer advice service
- c. A DVD rental company
- d. An insurance company

- a. *A book seller:* This is not an easy call. Specialist booksellers probably favour localized facilities due to their labour-intensive process, the physical nature of the product and customers that need personal contact to specify their needs. However, it is interesting to assess how the use of Meijboom and Houtepen's six factors can help explain the success of online book sellers such as Amazon, who use highly centralized facilities.

- b. *A consumer advice service*: This seems a clear case of favouring a centralized facility, especially if the advice does not require personal contact with customers.
 - c. *A DVD rental company*: Like the case of the bookseller, the physical nature of the product probably tips the balance in favour of localized facilities. However, once the product is digitized (which is now happening) centralized facilities are favoured.
 - d. *An insurance company*: Like the consumer advice service, this decision seems to hang on the extent to which customers need personal contact to specify their needs. Similarly, the more standardized the product, the more a centralized facility is favoured.
- 6. What type of focus (market, product or process) would be best suited to the facilities of an organization that manufactures the following?**
- a. **Computer hardware**
 - b. **Domestic white goods (washing machines, fridges, freezers, etc.)**
 - c. **Specialty foodstuffs**

Dornier *et al.* (1998) argue that selecting the most appropriate one involves a trade-off between two dimensions *Operations complexity* and *Marketing requirements*. So for each case:

- a. *Computer hardware* probably has medium levels of operations complexity and marketing requirements, favouring a product focus.
- b. *Domestic white goods (washing machines, fridges, freezers etc.)* probably have higher levels of operations complexity and marketing requirements, favouring a process focus.
- c. *Specialty foodstuffs* probably have low levels of operations complexity and marketing requirements, favouring a market focus.

- 7. Outline the main differences between an offshore facility, a source facility and a server facility. In each case, explain how they could enhance their respective strategic roles.**

An *offshore facility* produces a limited number of outputs at low cost, not just for local customers but also for customers in other parts of the world. It is established to access sources of low-cost resources, such as labour. Investments in technology and competences are kept to the minimum required for production. All

key decisions about technology, suppliers, logistics and finance are taken at headquarters rather than locally. An offshore facility can become a source facility if it can develop the specific expertise required to master the production of these products or the operation of these processes itself. This particularly requires it to develop competences in dealing with the suppliers on whom it relies for those products or processes. It requires taking responsibility for selecting and developing those suppliers and also learning how to respond to customer requirements in the markets that it serves.

A *source facility* produces a limited number of outputs at low cost, but it also acts as a focal point for specific components, products, or processes. Local managers can take decisions about sourcing and supplier selection. They also have more autonomy about production planning, process development, product customization and logistics. A source facility can enhance its strategic role to become a lead facility if it can enhance its existing competences in product and process development, beyond that of low cost, to encompass a wider range of objectives (e.g. to improve quality, speed, dependability or flexibility). This will almost certainly require it to access a broader range of skills and knowledge than was previously the case.

A *server facility* serves specific national or regional markets. It is established to overcome import tariffs and taxes, reduce logistics costs, overcome currency fluctuations, and other trade barriers. Local managers have limited autonomy to make minor changes to products and processes to suit local conditions. A server facility can become a contributor facility if it takes responsibility for product development and customization for the market that it serves. To do this, it must be able to assess the needs of the customers that it serves and modify its products and processes accordingly. Thus, it must enhance its marketing and technological competences.

8. What kind of international configuration would you expect to find for the following types of companies? Explain why.

- a. An auto manufacturer
- b. A fast-food company
- c. A management consultancy
- d. A pharmaceutical company

a. Most large *auto manufacturers* now adopt a global coordinated operations configuration. This is because they wish to maximize economies of scale and scope across their network of facilities, and take full advantage of low-cost locations wherever they are located. Typically, each facility will specialize on the production of a small range of models (often just one) which they may supply to markets anywhere

in the world. However, in some cases, automakers may also retain elements of a regional operations configuration, with some facilities concentrating on the production of models for their local region.

- b. Even the largest *fast-food company* will recognize the importance of local tastes and cultural preferences. So, they will tend to operate a multidomestic operations configuration. This requires them to set up and operate facilities in every country in which the organization does business. They are also likely to draw on local food suppliers. Much of this is necessary to overcome import restrictions and trade barriers. However, this configuration also ensures that their operations are close to their customers (both literally and metaphorically), so that they can better tailor their products and services to meet local tastes.
- c. *Management consultancies* tend to adopt configurations that match those of their clients, so that they can best meet their needs. So, those management consultancies with large MNE clients will tend to display global coordinated operations configurations, so that they can operate at the same size and scope as the client.
- d. Major *pharmaceutical companies* tend to be MNEs with global coordinated operations configurations, and with each production facility specializing in a narrow range of tasks and supplying markets globally in order to simplify the operations at each facility and seek economies of scale. However, they are more likely to seek out locations which can offer superior resources and capabilities rather than just low costs, especially for their R & D facilities.

9. How should a firm set about designing an international network? What factors should it take into account?

Taking a network perspective enables the full potential of the totality of an organization's operations facilities to be realized. The aim in designing an international network should be to determine how best to configure all the organization's operations facilities to best serve its customers wherever they are in the world.

The strategic capabilities of an international network of operations facilities derive from four factors: strategic targets' accessibility, thriftiness ability, operations mobility and learning ability. All these factors need to be analysed in order to assess a network's ability to achieve the operational performance objectives required for the organization's business strategy.

CHAPTER 5

1. What are the most important factors that can affect the capacity of any operation?

As Hayes *et al.* (2005: 77) have noted, capacity is ‘a complex interaction of physical space, equipment, operating rates, human resources, systems capabilities, company policies, and the rate and dependability of suppliers’.

Capacity is affected by many interrelated factors, including the size and location of each of an organization’s facilities, and the size, type and mix of equipment, and the working practices at a single facility (e.g. shift patterns, working hours and staffing levels).

2. What factors affect the capacity of the following types of organization:

- a. A winemaker
- b. A university
- c. A hospital
- d. A motor car manufacturer with factories in several countries
- e. A chain of fast-food outlets

As discussed in the chapter, capacity can be affected by many, often interacting factors. Here are some suggestions for these examples:

- a. *A winemaker*: Capacity is most likely to be affected by the availability of suitable grapes and the processing capability of the winemaking equipment (particularly the storage capacity for fermentation and aging).
- b. *A university*: Capacity is most likely to be affected by the number and size of teaching rooms and other facilities (e.g. science laboratories) and numbers of staff qualified to teach the various subjects. Additional capacity can normally be created by scheduling classes outside of ‘normal’ teaching hours and by hiring part-time or temporary teaching staff. Another capacity constraint might be the availability of living accommodation for students on campus or in the local area.

- c. *A hospital*: Capacity is most likely to be affected by facilities such as the number of operating theatres and recovery ward beds, specialist medical equipment and trained medical staff. The number of patients that can be treated will vary greatly by the range and severity of the conditions.
- d. *A motor car manufacturer with factories in several countries*: The total capacity of the company will be restricted by the processing rate of the assembly line at each plant, which will be affected by the number of hours worked. Although output might be increased by increasing the number of hours worked, capacity might still be constrained by the availability of labour and the ability of suppliers to produce sufficient quantities of components. The ability of the company to meet customer demand will also be limited by vehicle type, as most car plants can only manufacture one type of vehicle. Although finished products from a factory in one country can be used to meet demand in other countries, this is also likely to be constrained by requirements for product variants for different countries.
- e. *A chain of fast-food outlets*: Capacity at any one outlet is most likely to be affected by the size of equipment and the number of staff employed, which will be affected by the size of the premises. As cooked food cannot be stored, each outlet can only meet demand from customers in its immediate vicinity.

3. Explain what capacity means for the following operations, and how it might best be measured.

- a. **An oil refinery**
- b. **A taxi service**
- c. **A shopping mall**
- d. **An airport**
- e. **A clothing manufacturer**

As discussed in the chapter, measuring capacity is often not a straightforward task. Here are some suggestions for these examples:

- a. *An oil refinery*: Capacity means the total volume of crude oil that can be processed. As oil refining is a continuous process, capacity might usefully be calculated as the plant's hourly design capacity (i.e. its total processing rate per hour). However, effective capacity would need to be measured making allowance for planned stoppages (e.g. for maintenance).
- b. *A taxi service*: Capacity for a taxi service is determined by the number and size of the vehicles and the number of hours they operate for. So, capacity could be measured in terms of numbers of "passenger hours", that is the number of passenger seats multiplied by the number of hours the taxi is available to

operate. Alternatively, as fares are often determined by distance travelled, capacity might be measured by “passenger miles”, that is the number of passenger seats multiplied by distance travelled during the working day. Another possibility is to ignore the number of passengers that could be carried and instead use measures such as the time occupied or the number of miles travelled whilst occupied.

- c. *A shopping mall*: Capacity for a shopping mall probably means the number of shoppers visiting each day (termed ‘footfall’ by retailers). Whilst this can be fairly readily measured (or at least estimated), the individual shops are more likely to be interested in how much shoppers spend on each visit.
- d. *An airport*: Capacity for an airport could be measured by the number of passengers passing through its terminals or the total number of landings and take-offs. The total number of passengers could be calculated from the total number of landings and take-offs and the capacity of each flight – however that would double count transfer passengers (i.e. those transferring from one flight to another).
- e. *A clothing manufacturer*: Capacity for a clothing manufacturer probably means the number of garments manufactured each day. However, using that as a measure would take no account of mix and types of garment produced, which could significantly affect the capacity.

4. The Waggy Tails dog grooming company has eight mobile units that visit dog owners’ homes. On average, it takes an hour to wash and groom each pet. Dog groomers are available for seven hours of work a day (after taking account of their meal breaks), five days a week. Holidays and sickness absence reduce their availability by 25 per cent. The company charges by the hour and typically bills the equivalent of 120 hours per week. What is the capacity utilization and efficiency of the operation?

Actual output = 120 per week

Design capacity = 8 units x 7 hours x 5 days = 280 hours per week

Planned loss = 25% x 280 = 70 hours per week (Although, it could be argued that unlike holidays, staff absence (e.g. for sickness) should not be considered as a ‘planned’ loss).

Effective capacity = Design capacity - Planned losses = 280 – 70 = 210 hours per week

Capacity utilization = $\frac{\text{actual output}}{\text{design capacity}} = \frac{120}{280} = 42.9\%$

Efficiency = $\frac{\text{actual output}}{\text{effective capacity}} = \frac{120}{210} = 57.1\%$

5. What are the principal features of the most important methods used in both quantitative and qualitative forecasting?

Quantitative methods are either based on:

- *Time series analysis*, which involves extrapolating past data into the future. Mathematical techniques are used to look for patterns in the data over time. This might involve smoothing out random fluctuations in the data by averaging the data over a longer time period using moving average calculations (e.g. for a month, a quarter, or even a year) or by using exponential smoothing techniques. Sometimes, it is possible to decompose the data into its different components using more sophisticated mathematical techniques. The intention is to distinguish a trend from random changes in demand by removing the effect of cyclical and seasonal movements.

or

- *Causal analysis*, which seeks to identify and model any cause and effect relationships between demand data and some other variable. Causal forecasting typically uses complex techniques of analysis such as linear regression, curvilinear regression and multiple regression.

Qualitative methods use subjective techniques. The main techniques used are:

- *Market surveys*: data is collected from customers about their future buying intentions. In mass consumer markets, this is likely to involve conducting a survey of a sample of customers.
- *Delphi studies* canvas the opinions of a panel of experts, questioning them independently about future trends. This usually involves a number of iterations of circulating panel members' views anonymously around the group until a consensus is reached.
- *Scenario planning* requires a team of experts to construct a small number of likely future 'scenarios' that the organization might face. Each scenario is based on different combinations of likely future situations.

6. What are the main advantages and disadvantages of both the quantitative and the qualitative approaches to forecasting?

Quantitative methods are fairly simple and easy to use. (However, causal analysis does use more sophisticated techniques). Assuming that data is available, as long as someone suitably trained is also available, the techniques are fairly cheap to use. They can provide numerical output that managers typically find useful as the basis for future plans. The biggest disadvantage with all quantitative methods is that they are based on the premise that the past can be used to predict the future. This may not always prove to be the case.

Qualitative methods use subjective techniques based on estimates and judgment to try to predict future demand. The advantage of market surveys is that they try to canvas customer opinions. However, such data can be costly and time-consuming to collect. The meaningfulness of the data depends on the design of the questionnaire, the use of an appropriate sampling method, and the extent to which customers' replies can be trusted. Other techniques such as Delphi studies and scenario planning have the advantage of encouraging potentially new and more creative thinking about future possibilities that the organization may face. Qualitative methods force managers to think more deeply about the future than might be the case if they simply accept the output from quantitative methods. However, people's thinking about the future is typically constrained by their experiences of the past.

7. Compare the advantages and disadvantages of increasing capacity with a *capacity leads demand* strategy with that of a *capacity lags demand* strategy for the following types of organizations:

- a. **A manufacturer of high-technology consumer electronic products**
- b. **An electricity generator**
- c. **A mobile phone network provider**
- d. **An airline**

a. *A manufacturer of high-technology consumer electronic products*

A *capacity leads demand* strategy would enable the organization to meet demand for the new products that any manufacturer of high-technology consumer electronics should be bringing to market. This should enable the organization to establish market share in growth markets. Having more than enough capacity to meet increasing demand should also lead to an incremental lowering of unit costs due to economies of scale, enabling the organization to reduce prices to further stimulate demand and further increase market share, leading to higher volumes which can further reduce unit costs. The main disadvantage of a *capacity leads demand* strategy is that demand may not increase as expected, leaving the organization with underutilized capacity. A *capacity lags demand* strategy avoids the technological

risks associated with new products and processes. However, it leaves the organization at risk of not being able to meet rising customer demand, thereby leaving market opportunities for competitors.

b. *An electricity generator*

In capital-intensive industries, where investment costs may be high and no producer will want to risk having underutilized capacity, a *lead capacity* strategy can have a number of advantages. Adding capacity ahead of competitors can enable the organization to build market share. Competitors might also be deterred from adding additional capacity in order to avoid excess capacity that they might only be able to sell by reducing prices. The disadvantage with a lead capacity strategy is that short-term profitability can be threatened by high capital investment costs and the possibility of initially high unit costs.

c. *A mobile phone network provider*

In growth markets, a *lead capacity* strategy has the advantage of enabling the organization to establish the high market share that should enable it to become profitable in the longer term from rising sales which it can meet with falling unit costs. However, in mature markets, where increased sales can only be achieved by taking market share from competitors, a *capacity lags demand* strategy might have a number of advantages. The organization can conserve its cash and keep its investment options open for longer, thereby being able to install the next generation of technology as soon as it becomes available. Also, it should be able to achieve a high rate of capacity utilization, achieving low unit costs through economies of scale.

d. *An airline*

A *capacity leads demand* strategy can have advantages where the airline is seeking to create new demand or enter new markets. Having extra capacity means that the organization should be well placed to use lower prices as a means to stimulate extra demand. This can then be used to create the virtuous circle of lower prices leading to higher volumes, which leads to lower costs which enables lower prices and so on. Competitors operating at full or near full levels of capacity can only match price cuts by sacrificing short-term profitability.

8. What capacity management strategies would you expect the following types of operations to adopt?

- a. An ice cream manufacturer
- b. A city centre hotel
- c. A steel manufacturer
- d. A telephone call centre
- e. A grocery supermarket

- a. *An ice cream manufacturer:* Demand for ice cream is seasonal and weather dependent. To some extent, a level capacity is appropriate as stocks can be built up during the winter months. However, as the product has a limited shelf life and is costly to store, manufacturers are likely to want to avoid high levels of stock. Consequently, they may also operate a chase demand strategy, increasing and lowering output levels with the seasons.
- b. *A city centre hotel:* As capacity is fixed to a large extent, any hotel will try to use demand management to maximize room occupancy. Typically, prices will be lowered over the weekends and holiday periods to try to attract non-business customers.
- c. *A steel manufacturer:* Steelmaking is a very capital-intensive industry that uses continuous processing technology. Consequently, manufacturers will favour a level capacity strategy to maximize utilization and economies of scale.
- d. *A telephone call centre:* This is a labour-intensive operation and so a chase demand strategy will be attractive. The aim will be to match staffing levels with demand for the service.
- e. *A grocery supermarket:* The only aspect of this operation that has any flexibility is staffing levels, particularly for till operators. So, a chase demand strategy will be used to try to match staffing levels with anticipated demand.

9. What factors should be taken into account when deciding on the size of an additional increment of capacity?

Firstly, the organization will want to ensure that it can utilize any additional capacity in order to achieve economies of scale and avoid any underutilization that might lead to rising costs. Secondly, it will need to take into account any minimum size requirements in the equipment dictated by the available process technology.

Thirdly, it will want to examine the direct and indirect capital investment costs associated with the capacity increment. Finally, it will want to avoid an expansion of capacity at an existing site that might lead to any diseconomies of scale.

10. Critically evaluate the effectiveness of the different actions that might be taken as part of a chase demand capacity management strategy by a manufacturer based in the following countries.

- a. The People's Republic of China
- b. France
- c. India
- d. Canada

- a. *The People's Republic of China*: China has a fairly unregulated labour market. So, typical actions might involve varying working hours, hiring and firing staff, and using temporary and part-time staff.
- b. *France*: In contrast to China, France's labour market is highly regulated and labour costs are high. Therefore, varying working hours and hiring and firing staff is less attractive. It is possible to use temporary and part-time staff to some extent. However, greater use might be made of subcontracting and multi-skilling the existing workforce.
- c. *India*: The situation in India is in some respects similar to that in China. So, varying working hours, hiring and firing staff, and using temporary and part-time staff are likely to be popular.
- d. *Canada*: Canada's labour market is less restricted than France, so varying working hours, hiring and firing staff and the use of temporary and part-time staff is probably viable. However, the relatively high labour costs are likely to encourage multi-skilling to increase flexibility.

11. On average, a telephone call centre receives 100 calls an hour. Calls take five minutes on average to resolve. How many staff should always be available to answer the phones if the call centre is to meet its targets of answering all incoming calls within one minute?

From queuing theory, the waiting time

$$W = \frac{a}{c(c-a)} \text{ hours}$$

Where a = the average number of customers arriving per hour, and

c = the average number of customers that can be served per hour

Now, $a = 100$ per hour

If one operative takes 5 minutes to resolve a call, then one operative can deal with 12 calls per hour

So, $c = 12 \times$ the no. of operatives on duty.

The waiting time can be calculated using a trial and error method (i.e. calculate the waiting time trying various numbers of operatives on duty) until the waiting time comes to less than one minute (i.e. 0.01667 hours).

With 12 operatives,

$$W = 100 / 12 \times 12 (12 \times 12 - 100) = 100 / 144(44) = 100/6336 = 0.01578 \text{ hours}$$

= 0.947 minutes, just under one minute.

Thus, the minimum number of operatives on duty at any one time needs to be at least 12 if W is to be no more than 1 minute.

CHAPTER 6

1. What are the main factors that need to be taken into account when deciding what type of process technology to use in an operation?

The main factors are:

- *The volume and variety of output* that the technology can achieve. As volume and variety are typically inversely related, there is normally some degree of trade-off required in process technology choice.
- *The fit with existing technology* used within the organization. Considerations will include the requirements for training staff to operate and maintain new technology and any need to increase stockholding maintenance spares and different input materials for the new technology.
- *The level of maturity of the technology*: adopting new technology is inherently risky. Hence, consideration needs to be given to what organizational capabilities will be required to operate and maintain new technology.

2. What types of material-processing technologies are likely to be used in highly automated factories? What types of products are likely to be most easy to manufacture using highly automated technology?

Highly automated factories are likely to make use of integrating technologies that link together forming and moving technologies, and possibly also design technologies. These include:

- Computer-aided design/computer-aided manufacturing (CAD/CAM) systems that enable designs from CAD systems to be transmitted to the computer numerically controlled (CNC) machines of a CAD system for automatic programming for manufacture.
- Flexible manufacturing systems (FMSs) that comprise groups of CNC machines linked together by automatic materials handling (AMH) technologies (moving technology). The AMH technologies enable each CNC machine to be automatically loaded and unloaded, and for material to be moved from one machine to another in accordance with the manufacturing process plan for each item.

- Computer-integrated manufacturing (CIM) systems that integrate CAD/CAM with FMSs to create a fully integrated manufacturing operation, controlled by a single computer system.

Highly automated technology is best suited to the repetitive manufacture of similar products that enable high volumes to be achieved. High volumes are needed to justify the high capital investment costs and to achieve low unit costs from economies of scale. Automated technologies still have their limitations and require much more human intervention if product variety is too great.

- 3. Visit a large service organization (e.g. a retailer, a theme park, a mass transit system) as a customer. What customer-processing technologies do you encounter? What type of customer-technology encounters are these? How effective are the technologies that you encountered?**

Clearly your answer will depend on the organization you visit. But you should look out for examples of:

- *Passive interactions*, where the technology controls the interaction with the customer.
- *Active interactions*, where the customer controls the interaction with the technology.
- *Supported interactions*, where a human server acts as an intermediary between the customer and the technology.

- 4. How have some organizations used digital technologies to transform their business operations in the following industries?**

- a. Air travel**
- b. Book publishing**
- c. Recorded music**
- d. Grocery retailing**

- Air travel*: Although the low-cost airlines initially pioneered the use of online booking, most airlines now have websites where customers can book flights, reserve specific seats, choose their food, check in and even print off their boarding cards. The Internet has also spawned a new breed of online intermediaries that enable customers to compare flight details and prices from any airlines.
- Book publishing*: Book publishing has been affected in both the production and distribution stages. The Internet enables books to be printed at sites far remote from writers, editors, designers, etc., enabling

publishers to make use of low-cost locations. ICTs also enable much smaller print runs to be achieved economically and for books to be customized at relatively low volumes. Book selling has been revolutionized by online retailers such as Amazon. Although the technology exists to replace hard copy with e-books, this has yet to achieve widespread acceptance.

- c. *Recorded music*: The distribution of recorded music is in the process of being revolutionized by Internet ICTs. Online downloads are fast replacing physical recordings like CDs. This is impacting various stages of the supply chain, but especially recorded music stores.
- d. *Grocery retailing*: Online grocery retailing is offered by many of the major supermarkets in advanced economies. Customers can order their groceries online for delivery to their homes by the retailers. Different retailers have developed different models for this business.

5. What factors should an organization take into account in determining whether it should be a technology leader or technology laggard with regard to its adoption of new process technology?

Any organization contemplating making investments in new technology for its operations is likely to want to assess its current competitive position *vis-à-vis* its industry rivals, as well as customer requirements, to determine its need to be at the forefront of technological advances. Being a technology leader requires both an appropriate culture and the necessary expertise and resources. Clearly, the organization must possess or have access to the necessary technological expertise to develop and utilize leading-edge technology. It must also be able to afford the required financial investments. However, as operating at the leading edge of technology is inherently risky, the organization must also be highly risk tolerant.

- 6. What are likely to be the most significant factors that a company will need to take into account when considering transferring some of its manufacturing process technology from an advanced Western country (e.g. in Europe or North America) to:**
- a. a rapidly developing country, such as China or Brazil; or
 - b. a less developed country, such as Pakistan or Liberia?

Transferring technology to any country requires an assessment of the 'transferability' of the process technology itself. Such an assessment requires investigating four key factors: knowledge; customization and obsolescence; adaptability; and packaging.

Additionally, the ‘appropriateness’ of any potential location needs to be assessed to determine the ability of the host destination to accept the technology without its adaptation. Nine key factors should be considered (Grant and Gregory, 1997):

- *Host labour*: Are a sufficient number of workers with the right knowledge, skills and attitudes available from the local labour market at affordable rates?
- *Transfer market*: Does the process have the capability and flexibility to produce outputs suitable for the target market?
- *Suppliers*: Does the location provide easy access to suppliers who can meet requirements for quality, cost, delivery and flexibility?
- *Host infrastructure*: Does the location have the necessary quantity and quality of supporting infrastructure (e.g. utilities, transport, telecommunications, buildings) at affordable costs?
- *Host organization’s resources and capabilities*: Does the local organization have the necessary technical and managerial capabilities to host the process technology?
- *Host culture*: Does the location have an organizational and national culture that is appropriate and compatible with the operation of the technology?
- *Host climate*: Are the local environmental climatic conditions appropriate for the process (e.g. temperature, rainfall, humidity, air quality)?
- *Financing*: Are the investment costs (e.g. land, buildings, inventories) of financing the transfer justifiable?
- *Host government and legal issues*: Are the statutory obligations (e.g. import duties, quotas, labour laws, environmental laws, planning laws, approval processes, licence requirements) imposed by the host country reasonable?

These factors should be examined for any specific location, whether a rapidly developing country (such as China or Brazil) or a less developed country (such as Pakistan or Liberia).

7. Use the volume-variety model to explain the difficulties inherent in designing a process to achieve high volume and high variety.

As the volume-variety matrices illustrated in Figures 6.4 *a* & *b* show, volume and variety have an inverse relationship. Therefore, the generic process types tend to sit on a top left to bottom right diagonal line across the matrix. Processes that facilitate increased volumes should lead to lower unit costs. But they also

tend to reduce flexibility and so reduce product variety. Trying to increase the flexibility of the process by moving away from the diagonal towards the top right tends to increase costs. This is because a higher variety makes it more difficult to standardize, leading to increased unit costs.

8. Visit a large branch of a retail bank. Which of the generic process types can you see in operation? How appropriate do these processes seem to be for the volume and variety of output you observe?

Retail banking operations in a typical banking hall are often good examples of service shops. They often contain a mixture of processes. Customers wishing to undertake simple transactions (e.g. withdraw cash, make a deposit, currency exchange) are best served by mass service processes, waiting in line to be served by tellers. If transactions are of short duration, queues should not be too long. However, some customer transactions can be more complex (e.g. applying for mortgages or personal insurance) or customers may require personal advice (e.g. savings and investments). Such interactions are more suited to professional service processes. If banks attempt to meet these requirements with the same mass service processes as simple transactions, then long waiting lines are almost inevitable.

9. What type of layout would you expect to see in the following operations?

- a. TV manufacture
- b. The kitchen of a large luxury hotel
- c. A telephone call centre
- d. An aircraft manufacturer

- a. *TV manufacture*: TV manufacture is usually high volume, low variety, so is suited to mass manufacturing processes, almost certainly based on the *product* layout of an assembly line.
- b. *The kitchen of a large luxury hotel*: This is likely to require a process that can deliver a combination of medium variety and medium volumes, best suited to jobbing or batch production. The layout is likely to be *process* with different areas dedicated to specific tasks (e.g. food storage, food preparation, ovens, hot plates, etc.).
- c. *A telephone call centre*: This is a mass service operation with individual operatives each handling many calls. As each operative will typically be working individually, to some extent layout is irrelevant as long as each operative has access to the necessary technology (usually a telephone and computer). However, there might be some benefit in creating 'cells' of operatives who handle

similar calls. This might help to create a team spirit, improving working life for operatives and also enabling operatives to share knowledge associated with their particular types of calls.

- d. *An aircraft manufacturer:* Aircraft are typically produced one at a time and so their manufacture is best considered as a project or jobbing process. This is best suited to a *fixed position* layout in which all the resources move to the place where the aircraft is being assembled.

10. In an office processing applications for insurance policies, each application takes 30 minutes on average to process. The office works a 35-hour week. How many workers are needed to ensure that the office can meet its target of processing 2,000 applications per week?

- Throughput time is the time taken to process an item (or person) from the time of entry to the time of leaving.
- Cycle time is the average time to process one item.
- Work in progress is the number of items within the process at any point in time.

Work in progress = 2,000 applications

Time available = 35 hours

Average processing time = The time taken for each application to be processed = 30 minutes

Throughput rate = 2 per worker per hour = $2N$ (where N = no. of workers)

From Little's Law, Work in progress = Throughput rate x Time available

$$2,000 = 2N \times 35$$

$$N = \frac{2,000}{2 \times 35} = 28.6$$

So, 29 workers would be needed.

11. Think of an example of queuing that you have recently experienced as a customer. To what extent did the service delivery system utilize Maister's principles of the psychology of queuing to improve your wait?

Your answer to this will depend on your specific experience. However, when writing your answer you should consider Maister's (1985) principles of the psychology of queuing:

1. Unoccupied time feels longer than occupied time.
2. Pre-process time feels longer than in-process waits.
3. Anxiety makes the wait seem longer.
4. Uncertainty makes the wait seem longer.
5. Unexplained waits seem longer than explained ones.
6. Unfair waits seem longer than fair ones.
7. The more valuable the service, the longer people will wait.
8. Solo waits seem longer than waiting in a group.

Was the queuing system which you experienced designed with these principles in mind?

CHAPTER 7

1. Explain why operations managers need to be concerned about their supply networks.

No operation exists in isolation. Rather they depend upon their supply network – that is the set of interconnected relationships between all the parties that supply inputs to, and receive outputs from an operation. Therefore, operations managers need to take a holistic perspective of the supply network as a whole in order to maximize the benefits available. The success of any supply network depends on its ability to satisfy the needs of the ultimate customer, the end consumer of its products and services. Therefore, the supply needs to be designed and managed in a way that enables it to do so as efficiently and effectively as possible.

2. Calculate the impact on profitability of a 5 per cent reduction in the cost of bought-in goods and services, if such costs represented 25, 50 and 75 per cent of total organizational costs.

- A reduction of 5% in costs of bought-in goods and services when these are 25% of total costs = reduction in total costs of 1.25%.
- A reduction of 5% in costs of bought-in goods and services when these are 50% of total costs = reduction in total costs of 2.5%.
- A reduction of 5% in costs of bought-in goods and services when these are 75% of total costs = reduction in total costs of 3.75%.

3. Why is supply chain management sometimes referred to as ‘virtual integration’?

The idea of vertical integration is that organizations seek to control resources by owning them. The aim of supply management is to achieve a similar level of control of resources without ownership. The idea is to integrate activities throughout the supply network, using information to manage physical resources without having to own them. Thus, supply chain management can be thought of as virtual integration.

4. Why should organizations streamline and rationalize their supply networks?

Rationalization of the supply network should lead to fewer but deeper and closer relationships with suppliers (and customers). It should also lead to lower transaction costs, as many fewer transactions should result (even though the value of each transaction is likely to increase.) Rationalizing the supply network does not just reduce the numbers of suppliers and customers; it also involves selecting who should be part of the supply network. This means selecting suppliers who have distinctive competencies in the production of the required resource input that support the organization's operations strategy. Whilst this might be the ability to achieve low costs, it might also be the ability to achieve high quality, fast delivery, dependable performance, flexibility, and so on. Selecting suppliers also requires taking a future orientation as the world of business does not stand still. Organizations need to consider both how their own requirements of their suppliers might change in the future and how the competencies of the supplier might change over time. Selecting customers is to some extent a marketing issue, based on an assessment of their likely future purchasing requirements. However, the selection of customers should also take into account the ability of the supplying organization to meet their existing and future needs. This needs to be based on an assessment of the organization's existing distinctive competencies and how these will need to be developed in the future. In turn, these competencies will also depend upon the distinctive capabilities of the organization's suppliers.

5. Return to the *Crunching the numbers* exercise on the bullwhip effect. If the monthly demand for the OEM's product fluctuates as follows:

Month 1 – 1,000

Month 2 - 950

Month 3 – 1,000

Month 4 – 950, and so on

- a. Recalculate the impact on production levels at the tier 1, tier 2 and tier 3 suppliers, using Table 7.1 as a template, assuming that each supplier aims to keep one month's inventory.**
- b. What actions could be taken to reduce the impact of the bullwhip effect?**

a. These figures show the extreme fluctuations in demand suffered by the second tier supplier and particularly the third tier supplier, for whom this is probably unsustainable.

Month		Third tier supplier		Second tier supplier		First tier supplier		OEM		Demand
		Production	Stock	Production	Stock	Production	Stock	Production	Stock	
1	Start	1000	1000	1000	1000	1000	1000	1000	1000	1000
	End		1000		1000		1000		1000	
2	Start	200	1000	600	1000	800	1000	900	1000	950
	End		600		800		900		950	
3	Start	2600	600	1600	800	1200	900	1050	950	1000
	End		1600		1200		1050		1000	
4	Start	0	1600	300	1200	750	1050	900	1000	950
	End		1300		750		900		950	
5	Start	2000	1300	1650	750	1200	900	1050	950	1000
	End		1650		1200		1050		1000	
6	Start	0	1650	300	1200	750	1050	900	1000	950
	End		300		750		900		950	

b. The main obvious action to take (but one which firms in supply chains seem to find difficult) would be to communicate end consumer demand directly to all stages of the supply chain. This would help suppliers at each tier to plan in full knowledge of known demand and existing orders and stock.

Other actions might include:

- Reducing order sizes and increasing their frequency, perhaps to weekly rather than monthly.
- Reducing delivery times.
- Reducing manufacturing lead times.
- Avoiding creating surges in demand due to price cutting and promotional campaigns if this is an issue.

- Reducing the number of stages in the supply chain (but this would be disruptive and a major step to take).

6. Compare and contrast CPFR and SCOR as methodologies for improving the performance of a supply chain.

Collaborative planning, forecasting and replenishment (CPFR) enables supply chain partners to jointly synchronize their business planning, sales forecasting, production and replenishment activities for raw materials and finished goods via a Web-based tool. This requires supply chain partners to exchange selected information to enable a long-term forecast to be developed and continuously updated, to provide supply chain partners with more reliable information on which to plan their operations. Its success relies on mutual trust and collaboration between supply partners.

Supply chain operations reference model (SCOR) enables any supply chain to be described in terms of six distinct business management processes: plan, source, make, deliver, return and enable. Each of these processes is described in increasing levels of detail from level 1 (the scope of the supply chain), level 2 (the configuration of the supply chain – make to stock, make to order, etc.) and level 3 (the specific business activities within the supply chain). The performance of all supply chain operations is then measured using one or more of the 150 key indicators recognized by SCOR. The performance measures are organized in the same hierarchical structure of three levels used in business process modelling. Performance measurement enables any gaps between actual and desired performance to be identified. These performance gaps then become the focus of improvement initiatives based on best practice analysis.

7. What are the advantages and disadvantages of each of the four generic configurations for international operations (home operations, multidomestic operations, regional operations and global coordinated operations)?

Configuration	Advantages	Disadvantages
<i>Home</i>	<ul style="list-style-type: none"> • Production is easier to control in a familiar environment • Easier to achieve economies of scale and scope from increased 	<ul style="list-style-type: none"> • No direct exposure to customers in overseas markets • Potential delivery problems due to extended supply chain

	volumes in home facility	<ul style="list-style-type: none"> • Increased complexity for home facilities due to increased product variety (due to tailoring for different markets) makes scheduling and quality control more difficult • Missing out on resources and capabilities in other countries • Cannot deliver provider-located services
<i>Multidomestic</i>	<ul style="list-style-type: none"> • Improved understanding of local markets • Easier to tailor products and services to meet local tastes • Simpler operations than home configuration, making for easier control • Can deliver provider-located services • Overcomes import restrictions and other trade barriers 	<ul style="list-style-type: none"> • Direct investment in every country of operation increases costs and risks • Difficulty of matching supply and demand in each country • Increased difficulty of achieving economies of scale or scope
<i>Regional</i>	<ul style="list-style-type: none"> • Closer to customers than home or global configurations • Can achieve regional economies of scale and scope • Simpler and more easily controlled operations than multidomestic configuration • Shorter supply chains than global configuration 	<ul style="list-style-type: none"> • Not as close to customers as multidomestic configuration • Fails to maximize economies of scale and scope • Fails to access potential lower cost and/or superior resources and capabilities available in other regions
<i>Global coordinated</i>	<ul style="list-style-type: none"> • Each production facility can specialize in a narrow range of tasks, simplifying the management of operations at each facility • Each facility can maximize economies of scale and scope • Each facility can be located in the best location to access low cost and/or superior resources and capabilities 	<ul style="list-style-type: none"> • Supply chains can be long and costly to operate • Production facilities can be remote from many customers

8. Why has outsourcing proved popular in recent years?

Much of the initial impetus for increased outsourcing seems to have come from organizations seeking to copy the sourcing practices of successful Japanese manufacturers. Globalization has also increased the opportunities to outsource, particularly to low-cost destinations. Increased outsourcing has further been driven by a belief that ownership is not a necessary prerequisite for control, and that organizations might be better advised to concentrate their resources and efforts on their core activities. The main advantages claimed for outsourcing include:

- Reduced costs
- Use of the expertise of the supplier
- Better inventory control
- Reduced capital employed
- Reduced headcount
- More accurate operating costs
- Concentrating on core business and activities.

9. Can an organization outsource too many of its activities?

There are a number of disadvantages of outsourcing, which include:

- Loss of control of operations that are outsourced.
- Quality is more difficult to control.
- Reliance on supplier can lead to price rises and/or threaten continuity of supply.
- Managing supplier requires different skills than managing in-house operations.
- In-house resources risk being underutilized.
- Commercial secrecy can be put at risk.

The more operations that are outsourced, the greater these risks become. Therefore, it is important to distinguish between different kinds of goods and services. Assessing the strategic value and the criticality of goods and services being considered for outsourcing can help inform outsourcing decisions. Four types of goods and services can be characterized:

- **Proprietary:** These are core products likely to be based on the organization's core competences. They should be kept in-house.
- **Commodities:** These are likely to be based on standardized and commonly available technology and so are best outsourced.
- **Novelties:** These are likely to be based on specialized and possibly restricted technology, but are not essential to the functioning of the final product. The make or buy decision may be finely balanced.
- **Utilities:** These are critical to the final product but are based on readily available technology. They should only be outsourced to a trusted supplier.

10. Should an organization always outsource to the lowest-priced supplier?

Buying on the basis of price alone is fraught with difficulties. It is better to consider the *total cost of acquisition* of goods and services, rather than the purchase price alone. This can be done using multiple purchasing criteria derived by considering the so-called five 'rights' of purchasing, that is purchasing goods and services of the right quality, in the right quantity, at the right time, from the right supplier, at the right price.

11. Why have so many organizations based in advanced economies been attracted to offshore outsourcing in newly industrializing countries? What are the disadvantages of offshore outsourcing with suppliers located in newly industrializing countries?

Most purchasing from newly industrialized countries (NICs) was driven, at least initially, by cost considerations. This has certainly been the case with much of the recent offshoring of manufacturing to China, and of IT and financial services to India. The disadvantages of outsourcing to such countries derive from the same risks as outsourcing more generally, namely:

- A loss of control of operations
- Quality is more difficult to control
- Reliance on supplier can lead to price rises and/or threaten continuity of supply
- Managing supplier requires different skills than managing in-house operations
- In-house resources risk being underutilized

- Commercial secrecy can be put at risk.

Some of these may be more acute in NICs, particularly:

- The difficulty of trying to control operations in a distant and unfamiliar location
- The difficulties of controlling quality in countries unfamiliar with Western quality requirements
- The exposure to rising prices in a rapidly developing country
- The risk of loss of commercial secrecy in countries that do not have the same legal and regulatory frameworks as developed countries.

12. What advice would you give to an organization considering offshoring for the first time?

Perhaps the best advice is that purchasing decisions should be made on the basis of identifying suitably qualified suppliers rather than buying on price alone. A newcomer's knowledge of supply markets in other countries is bound to be limited. Research may be difficult in countries with limited disclosure requirements. Differences in language, culture and working practices can complicate matters further. Global supply networks are also inherently more risky, as they may involve variability and uncertainty in currency exchange rates, economic and political instability, and changes in regulatory environments in different countries. Therefore, identifying a trustworthy supplier is paramount.

13. Assess the advantages and disadvantages of the *partnership* approach (cf. the *traditional* approach) to supplier relations.

In the partnership approach, the purchaser is looking to build a long-term relationship with the supplier. Contracts are placed using multiple criteria, with special emphasis being placed on the supplier's capabilities. Because purchasers typically have fewer suppliers, they can put more effort into monitoring suppliers and developing close working relationships. Many responsibilities can be offloaded to the supplier, including managing quality and developing new products. Similarly, suppliers will be expected to identify product improvement and cost-saving opportunities, which should enable prices to be reduced. The purchasers can concentrate their efforts on helping and supporting the supplier to do this, and also on taking a joint approach to solving any problems that may arise. This relationship can only work effectively if mutual trust is established between the parties. The disadvantage of the partnership approach lies in the

potential breakdown of the relationship or if trust cannot be established in the first place. This can leave the purchaser exposed to any failing or dubious practices by the supplier.

14. Can buyers and suppliers ever really trust one another in commercial relationships?

This is an open question and one that lies at the heart of the partnership approach to purchasing. You might usefully cite the prisoner's dilemma as a helpful framework to understand the issues. Also, it is probably no coincidence that most commercial examples of partnership purchasing relationships are between large powerful purchasers and smaller weaker suppliers. Trust takes time to establish and needs positive actions to build and maintain it over time.

15. In what circumstances would single sourcing rather than multi-sourcing be more advantageous to a purchaser?

Single sourcing is advantageous when the purchaser wants to build a deep and lasting relationship with the supplier in order to increase the supplier's commitment to the purchaser over an extended period of time. This may be especially desirable if the purchaser wants to work together with the supplier to solve problems, enhance quality and develop new products and services, or if the purchaser particularly needs to establish commercial confidentiality.

CHAPTER 8

1. What is the difference between planning and control?

The main difference between planning and control is in relation to the issue of time. Planning is normally concerned with determining the nature and timing of what actions should take place prior to their occurrence. Its main purpose is to arrange for resources to be provided, so that a particular action can be taken in order to achieve a desired outcome. Control is concerned with understanding what is actually happening in the operation at the same time that it is happening, or immediately afterwards. Its main purpose is to discover if any deviation from plan is occurring (or has occurred) and, if necessary, to make changes to the operation. However, as most operations are ongoing rather than one-off events, planning and control are continuing activities. As such, they usually become intertwined and distinguishing between them is practically impossible.

2. Why is matching supply and demand in operations such a difficult task in practice?

The difficulties in matching supply and demand largely arise because both can be dynamic. Demand can change in terms of the volume of demand, the type of product or service required by customers and where that demand arises. Changes in demand can arise from many factors (e.g. actions of competitors, changes in customer tastes and preferences, government legislation, weather) whose effects are typically difficult to forecast with any accuracy. On the other hand, supply can also be dynamic due to many factors (e.g. production difficulties, capacity constraints, failure of suppliers). Making adjustments in supply in response to changes in demand typically involves a time lag and may also have financial implications, adding to the difficulties of making necessary changes.

3. What are the main challenges for operations planning and control for an organization operating globally in comparison to one operating within a single country?

Planning and control is more challenging for an organization operating globally as it is likely to require the coordination of operations located in different countries, probably drawing on inputs sourced from other different countries, in order to meet demand from many other different countries. This not only

requires managing an operation of greater size than might be the case for any one domestic operation, but also managing much greater complexity, due to having to cope with a myriad of operating contexts with differing languages, cultures, laws, regulations, etc.

4. Think of at least three examples of customer-processing operations that use sequencing rules other than first come, first served.

Obvious examples include:

- A hospital emergency ward, where priority is given to patients in most urgent need irrespective of those already waiting.
- An airport check-in, where there are separate waiting lines for different classes of travel (e.g. economy, business, first class). Priority is given to passengers paying the highest fares.
- Restaurants who give priority to customers who have phoned ahead to book tables over those who just turn up without a reservation.

You can no doubt think of many other examples.

5. The following jobs need to be scheduled on a piece of equipment. Apply different sequencing rules to determine how to achieve: (a) the minimum late delivery to customers; (b) the minimum time the jobs spend in process; and (c) the minimum work in process.

Jobs	Processing time (days)	Customer due date (days hence)
A	10	15
B	8	14
C	7	10
D	5	9
E	3	6

Firstly, let us assume that once set up, all jobs are run through to completion.

Using the following sequencing rules:

Shortest processing time (In this case, this is also the same sequence as using the **earliest due date** rule).

Job sequence	Processing time (days)	Customer due date (days hence)	Time in process (days)	Lateness (days)
E	3	6	$0 + 3 = 3$	0
D	5	9	$3 + 5 = 8$	0
C	7	10	$8 + 7 = 15$	5
B	8	14	$15 + 8 = 23$	9
A	10	15	$23 + 10 = 33$	18

- (a) Total lateness to customers = 32 days
- (b) Total time in process = 82 days
- (c) Maximum work in progress = 10 days' work

First come, first served

(In this case, this is also the same sequence as using the **longest processing time** rule).

Job sequence	Processing time (days)	Customer due date (days hence)	Time in process (days)	Lateness (days)
A	10	15	$0+10=10$	0
B	8	14	$10+8=18$	4
C	7	10	$18+7= 25$	15
D	5	9	$25+5=30$	21
E	3	6	$30+3=33$	27

- (a) Total lateness to customers = 67 days
- (b) Total time in process = 116 days
- (c) Maximum work in progress = 10 days' work

6. A work centre is scheduled to process the following jobs over the next 4 weeks:

Job no.	Required work hours	Due date (end of week)
1	12	1
2	6	1
3	14	1
4	6	1
5	18	2
6	10	2
7	7	2
8	18	3
9	12	3
10	5	3
11	20	4
12	10	4
13	6	4
14	5	4

If the work centre has a capacity of 35 hours per week, draw up a workload using the forward-loading and backwards-loading approaches. Ensure that your solution solves any overloading problems. Which of the two approaches do you consider to be the most effective in identifying and solving overloading problems?

Forward Loading:

Week 1					TOTAL
Job No.	1	2	3		
Hours:	12	6	14		32

Week 2					TOTAL
Job No.	4	5	6		
Hours:	6	18	10		34

Week 3					TOTAL
Job No.	8	9	10		
Hours:	18	12	5		35

Week 4					TOTAL
Job No.	11	12	14		
Hours:	20	10	5		35

Week 5					TOTAL
Job No.	7	13			
Hours:	7	6			13

This solution has not exceeded the 35 hours per week capacity constraint, but has required that some jobs will run over into week 5. (There could be other scheduling solutions). Additional resources would be needed to meet all due dates.

Backward Loading:

Week 1						TOTAL
Job No.	1	2	3	4	13	
Hours:	12	6	14	6	6	44

Week 2						TOTAL
Job No.	5	6	7			
Hours:	18	10	7			35

Week 3						TOTAL
Job No.	8	9	10			
Hours:	18	12	5			35

Week 4					TOTAL
Job No.	11	12	14		
Hours:	20	10	5		35

Again, other scheduling solutions are possible. However, this approach also highlights the impossibility of meeting all due dates, but perhaps better draws attention to the need to take immediate action if this is deemed unacceptable.

7. A hotel wants to staff its reception desk to the hourly levels set out in the table below:

Time	Required
08:00	4
09:00	4
10:00	4
11:00	6
12:00	8
13:00	8
14:00	4
15:00	4
16:00	8
17:00	8
18:00	4
19:00	4
20:00	4

If each receptionist normally works a four-hour shift, design a workforce schedule to ensure that reception is fully staffed at all times.

Time	Staff nos.			
	Required	Start shift	End shift	On shift
08:00	4	4	0	4
09:00	4	0	0	4
10:00	4	0	0	4
11:00	6	2	0	6
12:00	8	6	4	8
13:00	8	0	0	8
14:00	4	0	4	4
15:00	4	0	0	4
16:00	8	6	2	8
17:00	8	0	4	8
18:00	4	0	0	4
19:00	4	0	0	4
20:00	4	0	0	4

There could be a number of possible solutions, but it looks as if they would all have to involve the use of split shifts (i.e. work say 2 hours, then go off for say 2 hours, then return to work).

8. To what extent is the use of expediting evidence of a failure to operate effective planning and control systems?

Expediting is the practice of making interventions in day-to-day operations in order to reschedule activities in response to short-term requirements. Although it might appear that such actions should be avoidable with better planning, in the real world operations managers may have to respond to unplanned events that could not have been anticipated, or could only be avoided if the operation had been carrying a high (and hence very costly) amount of spare capacity. Examples of when expediting interventions might be required include customers making a last-minute change to an order, a material shortage due to problems with a supplier, an important operator suffers a sudden illness, a piece of equipment breaks down, and so on.

9. Discuss the implications of different $P:D$ ratios.

The $P:D$ ratio compares the demand time D (i.e. the time taken from when a customer requests the product to when they receive it) with the throughput time P (i.e. the total time taken to produce the product or service). The $P:D$ ratio provides a useful way of understanding the implications of the different possible planning policies that could be used to meet customer demand. The $P:D$ ratio reflects the risk inherent in the planning policy being used. The higher the $P:D$ ratio, the higher the risk to the producer. This is because the more that activities are being undertaken on the basis of a forecast, the greater the chance that actual demand will vary from that forecast. On the other hand, delivery performance improves as the $P:D$ ratio increases.

10. What are the advantages and disadvantages of both supply-push and demand-pull as methods of control?

The supply-push approach aims to control the activities of each work center through a system of centralized control. In simple situations, this might be exercised by a shop floor manager or supervisor. In more complex operations, this might need a computerized system. The advantage of this approach is that work centres are independent of each other and so any disruption at one will not immediately affect another. However, if disruptions are not spotted and acted upon quickly enough, output from the preceding work centers will quickly build up as work in progress. Another advantage is that managers can see an overview of progress and ensure that suppliers are notified of requirements in time to prevent shortages of input resources. This is particularly important when demand is variable. The main problem with this approach is that it relies on the controller being provided with regular updated information, so that instructions can be amended to account for changes in customer orders, the progress of the work, breakdowns, material problems, etc. This can obviously become a highly complex task. In order to avoid disruptions, individual work centers may be tempted to build up stocks of input materials just in case of future disruption, thereby increasing inventory levels and possibly hiding quality problems.

Demand-pull treats the entire operation as one entity. Work is pulled from one work center to another through each work station only producing to meet the demand of the subsequent work centre. In this way, work-in-progress stocks are not allowed to build up. If a disruption occurs at any one process, it is quite acceptable for a prior work centre to stop producing until the problem is resolved. Indeed, it is a central

tenet of this approach that it is everyone's responsibility to remedy a problem anywhere in the system, so that the performance of the whole system can be improved. The role of the central controller is considerably reduced with a demand-pull approach. This use of computer power is not a prerequisite. However, the approach does rely on close cooperation between the different parts of the operating system. If the demand-pull approach is extended to include the wider supply network, then a similar level of cooperation is required from external suppliers. The main disadvantage of demand-pull is that it is very vulnerable to any disruption. If one part of the system stops, then the whole system will soon stop. Also, the relatively short time horizon of each work center makes it difficult for the system to cope with large variations in demand.

11. Explain the theory of constraints as an approach to production and control. To what extent is OPT based on the philosophy of supply-push planning and control, and to what extent is it based on demand-pull?

The theory of constraints (TOC) is based on the idea that there is always a 'bottleneck' in a production process (or production line). The bottleneck is that activity which has the lowest rate of throughput of all the activities in the overall production process. So, TOC argues that:

- The output of the overall production process is governed by the bottleneck operation because it is the bottleneck that constrains the overall rate of production.
- The optimal production schedule for the production process overall is determined by the rate of throughput at the bottleneck. Therefore, scheduling should be focussed around the bottleneck with all other activities synchronized with the bottleneck.
- Efforts to improve the throughput of the production process overall need to be focussed on the bottleneck.

So, identifying the bottleneck is essential to planning, control and improvement.

CHAPTER 9

1. What are the major differences between independent and dependent demand?

Independent demand is demand that occurs separately from that for any other item. Finished goods typically exhibit independent demand, normally determined by market forces. Demand for MRO items often appears to exhibit a random pattern due to the vagaries of their use by the people and equipment in operations.

Dependent demand, on the other hand, is demand that is linked to demand for another item. So, for example, a motor car manufacturer will know how many doors, wheels, seats, etc. it needs for each car. Knowing how many cars are intended to be made, it is possible to calculate the demand for every component part that goes into their assembly.

2. Should inventory be considered to be an asset or a liability for operations?

This is a classic issue for discussion.

The argument that inventory is an asset is based on the fact that inventory has a monetary value. This is recognized in any set of financial accounts, where inventory appears in the current assets column. Inventories are a valuable asset in operations as they act as a buffer against uncertainties in supply, for example due to irregular supply, in anticipation of fluctuations in demand, or as pipeline inventories (i.e. goods in transit). Sometimes inventory can help reduce the cost of acquisition - from lower prices for bulk purchases, reduced delivery costs for bulk purchases, reduced ordering costs, reduced set-up costs and price variability (e.g. seasonal). Having too little inventory also risks disruption and/or stoppages to operations due to stock-outs. This leads to higher operating costs, lost sales, deterioration in customer relations, damage to the organization's reputation, etc.

However, inventories can also be seen as a liability, due to the cost of holding stock. Having too much stock generally results in:

- An opportunity cost from the investment capital tied up in stocks
- Increased storage costs

- Increased insurance costs
- The risk of obsolescence
- The risk of deterioration, damage and pilferage.

High levels of inventory (particularly work-in-progress stock) can also hide production problems and inefficiencies. The JIT (just in time) philosophy aims to expose such problems by driving stocks out of the manufacturing system.

3. What type of inventory control system would you expect to find in the following operations:

- a. A car repair shop
- b. Aircraft manufacturing
- c. Motor car manufacturing
- d. A retail shop

- a. *Car repair shop:* Demand for the parts needed to carry out car repairs will be *independent demand* as it will arise in a fairly random manner. The best that the repairer can do is to hold stocks of regularly used items. The level of stocks held can only be forecast on the basis of past demand. Inventory control will be based on an order point system, either a reorder level or a cyclical review system. This type of operation will look for suppliers who can offer a speedy and reliable service to try to ensure that they can always meet customer demand.
- b. *Aircraft manufacturing:* Aircraft are very complex products to manufacture. Aircraft are manufactured one at a time to a specific, often unique design. Each aircraft requires many components, demand for which are typically 'lumpy' and which are often on long lead times from suppliers. However, the demand for the components is entirely *dependent demand*, so the quantities required and their timing can be calculated with a high degree of accuracy. This type of manufacturing is entirely suited to an MRP inventory control system.
- c. *Motor car manufacturing:* Motor cars are usually manufactured in large quantities in a repetitive mass production process. Demand for components is *dependent demand* and so can be calculated. Once the master production schedule has been determined, suppliers can be advised of daily delivery requirements well into the future, enabling them to devise long-term production plans. Although the actual quantities required for car manufacture will tend to be fairly stable, it will still vary to some extent on a daily basis. This makes motor car manufacturing suitable for a just-in-time inventory control system, in which suppliers are notified of exact requirements on a daily (or shorter) basis.

d. *Retail shop*: Demand for goods in a shop is usually considered to be *independent demand*. So, retailers typically operate a reorder level or a cyclical review system. However, demand for many goods is seasonal and can to some extent be forecast on the basis of past patterns of demand. In many cases, retailers seek to influence demand by advertising and promotions. This is often done in an effort to create demand for goods that are being stocked specifically for this purpose (e.g. fashion). However, some retailers try to operate on a lean (or quick response) basis, responding to changes in customer demand (in volume, variety, etc.) by having agile and responsive supply arrangements.

4. The demand for fizzy cola at a shop is constant at 800 a month. Each bottle of fizzy cola sells for £1.00. The cost of placing an order with the supplier of fizzy cola is £50, which includes delivery. The cost of keeping each bottle in the store room is estimated to be £7 per year. How many bottles should the shop order in each delivery?

Using the Economic Order Quantity formula:

$$EOQ = \sqrt{2AS/RV}$$

Where,

A is the cost of placing an order = £50

S is the annual demand (in units) for the item = $800 \times 12 = 9600$

R is the stockholding cost (expressed as a percentage of the purchase price) = $7/1 = 7$

V is the cost (purchase price) of the item = £1

$$EOQ = \sqrt{2AS/RV} = \sqrt{2 \times 50 \times 9600 / (7 \times 1)} = \mathbf{370}$$

It is likely that exact order sizes would be dependent on packing, so it might need to be in multiples of 12. So perhaps the practical EOQ might be 360.

5. What are the major shortcomings associated with use of the EOQ formula in practice?

The main shortcomings with the EOQ formula are:

1. It is very difficult (if not impossible) to calculate a meaningful figure for the cost of placing and processing an individual order in practice. At best, any figure is likely to be an average for all purchasing activities rather than that associated with a specific item.
2. While it is possible to calculate the annual demand for the item from the previous year's figures, this may not hold true for the present year. Also, demand may not be constant over the year. If it fluctuates significantly, then EOQ calculations are likely to give rise to either overstocking or stock-outs.
3. The cost of holding stock is also difficult to calculate in practice. It is likely to be made up of:
 - (a) the cost of capital, which may vary over time as interest rates change
 - (b) insurance costs, which may depend on the type of stock being held
 - (c) storage costs, which depend on building costs and any special facilities the items may require (e.g. heat, cold, humidity)
 - (d) obsolescence, which will vary especially if fashion or technology are involved
 - (e) deterioration and damage, which again depends on the items
 - (f) pilferage or other losses.
4. The cost of the item may vary over time (due to inflation or other market factors) and may also be subject to quantity discounts or small order surcharges.
5. Lead times may vary for many reasons, including the performance of suppliers (or their suppliers).

6. Use ABC analysis to classify the stock items in the table below. Explain why you designated each item class A, class B and class C respectively.

Item	Purchase price per unit (£)	Annual sales per item (£)
A	440	1,150
B	810	400
C	2,100	100
D	1,650	20
E	100	350
F	160	1,850
G	6,100	150

H	230	550
I	1,500	320
J	2,500	70

Item	Purchase price per unit (£)	Annual sales per item (£)	Total annual spend (£)
A	440	1,150	506,000
B	810	400	324,000
C	2,100	100	210,000
D	1,650	20	33,000
E	100	350	35,000
F	160	1,850	296,000
G	6,100	150	915,000
H	230	550	126,500
I	1,500	320	480,000
J	2,500	70	175,000

Then, rearrange the rows in descending order of *total annual spend*:

Item	Purchase price per unit (£)	Annual sales per item (£)	Total annual spend (£)
G	6,100	150	915,000
A	440	1,150	506,000
I	1,500	320	480,000
B	810	400	324,000
F	160	1,850	296,000
C	2,100	100	210,000
J	2,500	70	175,000

H	230	550	126,500
E	100	350	35,000
D	1,650	20	35,000 33,000
TOTAL			3,100,500

Calculating the percentage of annual spend on each item and the cumulative annual spend in ascending rank order, and applying an ABC ranking:

Item	Percentage total annual spend (%)	Cumulative total annual spend (%)	Classification
G	29.5	29.5	A
A	16.3	45.8	B
I	15.5	61.3	B
B	10.4	71.8	B
F	9.6	81.3	C
C	6.8	88.1	C
J	5.6	93.7	C
H	4.1	97.8	C
E	1.1	98.9	C
D	1.1	100	C

By inspection, it seems to make sense to classify the items as shown in the far right:

	Percentage of total number of items (%)	Percentage of total spend (%)
Class A	10	29.5
Class B	30	51.8
Class C	50	18.7

7. A company manufacturing lamps controls its material supply using a manual MRP system. Each lamp requires one base, two arms and one shade. Each joint requires one screw - one to fasten the base to the lower arm, one between the two arms, and one to fasten the shade to the top arm.

The latest information from the sales department shows expected orders as:

Week number	Predicted sales of lamps
1	0
2	280
3	80
4	160
5	120

The current stock levels and ordering information is:

Part	Opening stock for week 1	Delivery time from placing order with supplier	Economic order quantity
Finished lamp	20	1 week	50
Bases	360	1 week	100
Arms	600	1 week	300
Shades	600	1 week	150
Screws	300	2 weeks	1,000

Complete the requirements record cards below for each part for the four weeks. Remember to include the demand, opening stock, closing stock, orders released and deliveries received. State whether the current production forecast is realistic. If you identified any problems, what might be done to solve them?

Lamp	EOQ=50	Lead time = 1 week						
		Week	0	1	2	3	4	5
		Demand		0	280	80	160	120
		Scheduled receipts			300	50	150	150
		On-hand inventory	20	20	20	40	10	0

		Planned order release		300	50	150	150	
		Closing stock	20	20	40	10	0	30
Bases	EOQ=100	Lead time = 1 week						
		Week	0	1	2	3	4	5
		Demand		300	50	150	150	
		Scheduled receipts				200	100	
		On-hand inventory	360	360	60	10	60	10
		Planned order release			200	100		
		Closing stock	360	60	10	60	10	10
Arms	EOQ=300	Lead time = 1 week						
		Week	0	1	2	3	4	5
		Demand		600	100	300	300	
		Scheduled receipts			300	300	300	
		On-hand inventory	600	600	0	200	200	200
		Planned order release		300	300	300		
		Closing stock	600	0	200	200	200	200
Shades	EOQ=150	Lead time = 1 week						
		Week	0	1	2	3	4	5
		Demand		300	50	150	150	
		Scheduled receipts					150	
		On-hand inventory	600	600	300	250	100	100
		Planned order release				150		
		Closing stock	600	300	250	100	100	100
Screws	EOQ=1000	Lead time = 2 weeks						
		Week	0	1	2	3	4	5
		Demand		900	150	450	450	
		Scheduled receipts			1000			
		On-hand inventory	300	300	-600	250	-200	
		Planned order release	1000??					
		Closing stock	300	-600	250	-200	-650	-650

On the current schedule, manufacturing will run out of screws in week 1, so it will not be possible to meet the required production schedule.

Possible actions include:

- Seeking alternative screws or other fixings .
- Seeking alternative suppliers.
- Renegotiating the delivery schedule of finished lamps with the customer.

8. What challenges will a produce to order business need to overcome if it is to successfully adopt an MRP system?

Produce to order means waiting until a customer places an order before commencing production.

Operating a business on this basis using an MRP system therefore means orders would be placed with suppliers either on the basis of known or forecast orders. Waiting for actual orders to be placed would be problematic if lead times from suppliers were too long to meet customer requirements. Placing orders on the basis of forecasts risks the operation finishing up with unwanted stocks if the orders fail to materialize – thereby defeating the stock reduction objectives of MRP. If it is difficult to secure firm orders with long enough lead times or to improve forecasting, the only option is to improve supply arrangements by seeking suppliers who can provide speedy delivery of components. However, it might still be necessary to hold stocks of long lead time items.

9. What are the major problems associated with the implementation of MRP2 and ERP systems?

The main problems associated with implementing such systems are both technical and human. There can be technical difficulties with any new IT system, particularly compatibility with existing systems. However, the biggest problems are often human, especially gaining acceptance for the new ways of working required to successfully operate an ERP or MRP2 system. Operating computer-based planning and control systems requires that everyone involved acts with sufficient discipline to ensure that the system is constantly supplied with up-to-date information to reflect changes occurring in real time (whether from actions taken on the shop floor, modifications to designs, amendments to customer orders, and so on). If the computer software uses inaccurate or outdated data in its calculations, then the resulting instructions it produces will

be inappropriate and misleading. The situation is likely to be worsened if shop floor actions are then taken to expedite overdue or priority orders through the use of 'informal' systems outside of the formal MRP one.

10. To what extent can a line of waiting customers in a service operation be considered to be the same as work-in-progress inventory in a manufacturing operation?

It can be argued that a queue of customers in a service operation has many similarities with work-in-progress inventory. Advocates of lean thinking (see Chapter 10) would argue that just as work-in-progress inventory represents *muda* (waste), so a queue of customers wastes their time, ties up extra resources (e.g. space for customers to wait in) and hides processing problems. Queuing customers are a manifestation of *mura* (unevenness of flow) and *muri* (overburdening) of the operation; both of which should be avoided. However, there is a big difference between inventory and customers which is that customers are real people with emotions and feelings. If materials are kept waiting, unlike customers, they do not complain or threaten to take their business elsewhere! Organizations that treat their customers like inanimate objects are unlikely to retain them or attract new ones.

CHAPTER 10

1. What are the underpinning principles of lean operations?

Lean operations are based on the application of four interconnected principles:

- *Synchronization* – All stages of the production system make only what is needed to supply the next stage, when it is needed, in the quantity needed and delivered to where it is needed.
- *Eliminating waste* - Waste is considered to be any activity that consumes resources without creating value for the customer.
- *Continuous improvement* – Constantly seeking to improve all aspects of performance, especially quality.
- *The involvement of all employees* – Employees are seen not just as the means of implementing the instructions of managers or technical experts, but rather as an invaluable source of ideas and innovation, which if tapped into can help eliminate waste and achieve improvements.

2. Why did the practices of lean emerge in Japan, and not another country?

The practices that have become labelled as *lean* first emerged in Japan in the 1950s and 60s in response to the severe resource constraints being suffered by the country's industries after their defeat and devastation in the Second World War. These conditions, combined with the country's historic lack of natural resources and paucity of useable land, meant that all the ingredients required for manufacturers to produce the goods necessary to enable a hungry nation to feed itself had become highly precious commodities. The Japanese were thus forced to 'make the most of every last grain of rice'.

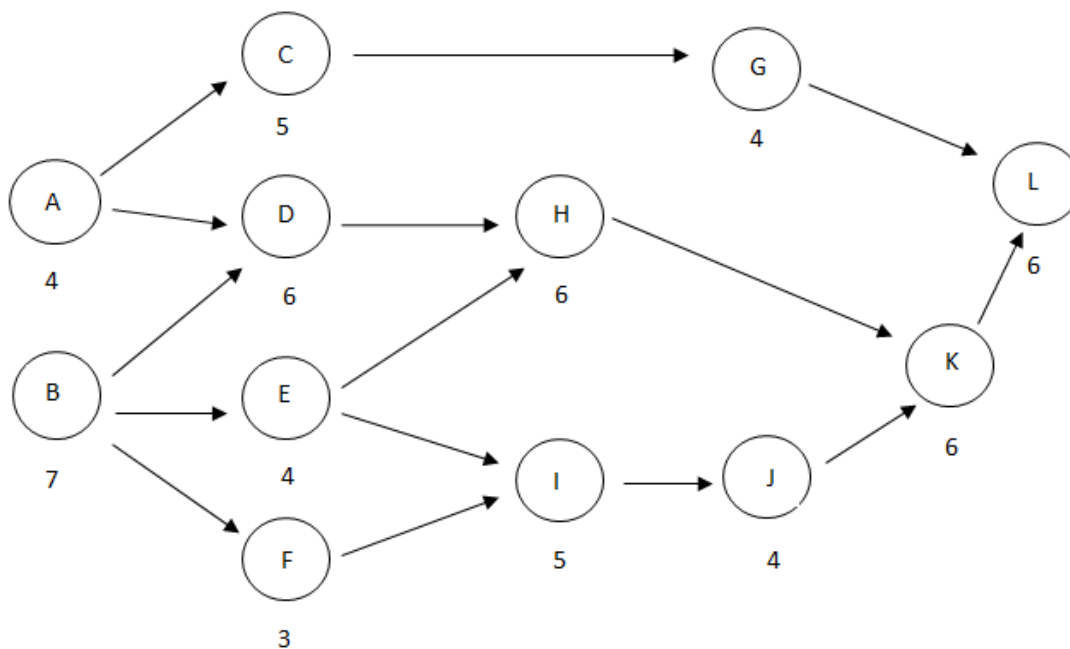
3. Using the data in the table, design a production line capable of producing three items per hour. Discuss the efficiency of the line.

Element	Duration (minutes)	Preceding element(s)
A	4	-
B	7	-
C	5	A
D	6	A&B
E	4	B
F	3	B
G	4	C
H	6	D&E
I	5	E&F
J	4	I
K	6	H&J
L	6	G&K

To make 3 items per hour requires a cycle time (C) of $1 \text{ hour}/3 = 60 \text{ minutes}/3 = 20 \text{ minutes}$

Number of work stations $N = T/C = 60 \text{ minutes of work} / 20 \text{ mins cycle time} = 3 \text{ stations}$

Precedence Diagram:



Balance the line:

Stage 1:

Time: 20 mins

Slack: 0 mins

Stage 2:

Time: 20 mins

Slack: 0 mins

Stage 3:

Time: 20 mins

Slack: 0 mins

This is 100% efficient – not a good solution. Aim for nearer 85%.

Alternatively, if you have 4 stations, where each is now going to add up to 15 mins each (60 mins of work to do in 4 stations. Note that cycle time is still 20 mins, but the work they have to do is 15 mins).

Station 1 = A, B and E

Station 2 = D, F and H

Station 3 = I, J and K

Station 4 = C, G and L

Stage 1: Time: 15 mins; Slack: 5 mins

Stage 2: Time: 15 mins; Slack: 5 mins

Stage 3: Time: 15 mins; Slack: 5 mins

Stage 4: Time: 15 mins; Slack: 5 mins

Efficiency is 75%:

more acceptable

But this might be hard to achieve in practice as the work elements are not directly next to each other. It might be possible by moving a worker from one place to another, or bending the line so worker 4 can get at tasks G and L without going too far from C. There may also be other solutions.

4. A workstation in a lean production covers seats for cars. It has a planned daily usage rate of 600 seats per day and receives uncovered seats from another station in containers that hold 5 per cent of the day's demand. It takes one hour for the preceding station to fill a bin and 30 minutes for the filled bin to be delivered to the covering station. How many such bins are needed for the *kanban* loop to work efficiently in this production cell, given a single eight-hour shift per day and a risk factor of 8 per cent?

The number of bins i.e. *kanbans* (production and conveyance) issued can be determined by the following formula:

$$N = \frac{D(Tw + Tp)(1 + r)}{c}$$

Where:

N = the total number of *kanbans* for a given part.

D = Planned usage rate for the part (parts per day).

Tw = Average waiting time for conveyance of parts (fraction of a day).

Tp = Average production time for a container of parts (fraction of a day).

c = Capacity of the standard container (number of parts). This must not exceed more than 10 per cent of daily usage of the part.

r = Policy risk variable, set by management expressed as a decimal fraction.

In this case:

D = 600 seats

Tw = 30 mins/8 hours = 0.5/8 = 0.0625 (no units as proportion)

Tp = 1 hour/8 hours = 0.125 (no units as proportion)

c = 5% of 600 = 30 seats

r = 8% = 0.08 (no units as scaling factor)

So, $N = 4.05$.

It would be sensible to round up to 5 to ensure that extra are created. Rounding down to 4 would risk causing a problem of understocking, leading to production stoppages.

5. To what extent does lean manufacturing preclude the use of international suppliers?

In a lean manufacturing system, suppliers are considered to be an integral part of the production process, rather like an extension of the factory which happens to be off-site. Thus, suppliers become part of the synchronous production pattern of JIT, producing exactly what is required just in time for its use in the factory. In a lean system, suppliers are typically required to deliver in small quantities several times a day. Operating a lean system leaves the factory at a very high risk of disruption if suppliers cannot meet delivery requirements. Trying to supply on this basis from an overseas source

would be difficult, if not impossible. One solution would be for the supplier to hold stocks in close proximity to its customer's factory. However, that is not in the true spirit of JIT. A further problem with an overseas supplier is that a lean manufacturer seeks to build close working relationships with suppliers in order to maintain the tightest levels of control and communications. A large geographic separation between buyer and supplier would make this very difficult to achieve.

6. What factors might limit the applicability of Ouchi's Theory Z in Western countries such as the US and the UK?

Ouchi's Theory Z combines the ideas of both scientific management and behaviouralism. It seems to explain common practices found in Japan. Theory Z is based on workers being very participative and capable of performing many varied tasks. Consequently, Theory Z emphasizes job rotation, broadening of skills, and continuous training of workers. However, in order to receive the benefits of this participation and flexibility, managers must be supportive and trusting of their employees. Theory Z organizations therefore focus on increasing employee loyalty by providing a job for life and focusing on the well-being of employees, both on and off the job. Although workers must take individual responsibility for their actions, decision-making tends to be collective. These conditions are typically not found in Western countries.

7. Explain how lean operations might be used to enhance flexibility.

There are various facets of lean operations that can enhance flexibility:

- Lean seeks to minimize machine set-up time (one of the seven zeros). This would provide more flexibility from faster changeovers between different products or services.
- Lean aims to minimize batch sizes (another of the seven zeros). This would add to flexibility by enabling faster switching between different products or services, without adding to costs.
- Lean aims to minimize inventory (another of the seven zeros), particularly WIP. This also enhances flexibility as it makes it easier to change production since it reduces the risk of unwanted stock.

- Lean seeks to develop multi-skilled workers who can work in self-directed autonomous teams. This offers increased flexibility as workers can easily switch between different tasks and can take immediate corrective action (e.g. in response to breakdowns or changing production schedules) without waiting for management instructions.
- Lean has a preference for a larger number of small machines (rather than a reliance on single large machines). This offers greater flexibility when it comes to breakdowns, maintenance and changeovers. Simple machines can be more easily maintained and modified by in-house workers and engineers, rather than having to rely on outside experts.

8. What are the main preconditions for the introduction of lean operations in an organization?

These include:

- Low set-up costs
- Fast set-up times
- Short supplier lead times (lean suppliers)
- Balanced production demand
- High quality levels (TQM)
- Suitable product design (DFM)
- Suitable work organization (high-trust environment, flexible workforce, self-directed autonomous work teams, etc.).

9. What are the main disadvantages for organizations operating with lean?

These include:

- The underutilization of capacity when there are no customer orders. (True lean requires a customer order before production commences).
- Its inability to capture economies of scale. (True lean produces in batches of one, rather than in batches of many).
- The difficulty of responding to significant changes in production volume.
- The increased importance and difficulty of product design.
- The need for cooperative suppliers, who also operate lean supply.

10. Should the operations of all organizations be lean? What limiting factors might there be?

It is difficult to argue with the principles of lean: eliminate waste, involve everyone and continuously improve. This perhaps explains the popular appeal of the lean production movement. It is beguiling to believe that these can be applied to any organization, whatever the nature of its operations.

However, it is worth remembering that the origins of lean lie in the mass manufacturing environment of car manufacture. Its success as a planning and control system based on supply-pull and as an inventory reduction system can be argued to rely on fairly fixed schedules with little variation in volume and variety (at least in the short term). It can also be argued that the outcome of lean is the deliberate stripping out of any excess resources in the production system. This leaves the system highly vulnerable to unexpected variations in demand and any disruption in the supply chain. Arguably, this may make lean unsuitable in many situations, particularly where demand is highly variable and supply is unreliable.

CHAPTER 11

1. How would you answer the criticism that TQM is just a fad whose time has passed?

TQM has been around for many years. Huge amounts have been written about it by academics, consultants and practitioners. There have undoubtedly been advances in quality, both in the quality of manufactured goods and in services. Yet, there is evidence that organizations often fail to deliver the level of quality that their customers want. Advocates of TQM would argue that quality problems still remain precisely because some organizations see TQM as a mere fad. TQM is a journey without an end. The underpinning principle of *kaizen* (continuous improvement) means that organizations need to pursue quality improvements unerringly and unendingly. As customer expectations increase and competitors improve their quality management, the imperative for all organizations to improve their quality management increases. As TQM is a set of principles rather than a set of specific practices, there will always be new ways of improving quality (a recent example of this is the Six Sigma approach to quality improvement).

2. How should the following organizations define quality in their operations?

- a. A motor car manufacturer
- b. A clothing manufacturer
- c. A supermarket
- d. An airline
- e. A university

There are no 'right' answers to this question. Rather, it is intended to provoke a debate about what is meant by the term quality in specific examples.

- a. *A motor car manufacturer:* There is an argument that the manufacturer should take an operations-based approach to defining quality in manufacturing operations, considering quality to be conformance to specification and defect-free production. They might also define the quality of individual models on a product basis. However, as their customers are more likely to

- take a perceived or user-based approach and value-based approach when considering their own purchases, the manufacturer might be advised to do likewise.
- b. *Clothing manufacturer*: The arguments for clothing manufacture are similar to those for motor car manufacture (although a product-based view is not very feasible for most clothes).
 - c. *A supermarket*: In supermarket operations, it is difficult to take a product-based or an operation-based view of quality. Similarly, a perceived view seems unlikely. This leaves a user-based or value-based approach.
 - d. *An airline*: An operations-based view could be used to consider service delivery issues such as on-time take-offs and landings. However, it might be better to use a user-based or value-based approach.
 - e. *A university*: Despite attempts to measure various aspects of quality in universities (essentially using a product-based approach), the concept of quality in education remains contentious and difficult to define. Most universities have to satisfy a wider group of customers than the students alone, making a user-based or value-based approach problematic. This may leave the perceived basis as the only viable alternative.

3. What quality gaps might there be in the following operations?

- a. **A budget airline**
- b. **A traditional full-service airline**
- c. **The latest computer game**
- d. **An expensive watch**

In each case, any of the five possible quality gaps might be an issue. However, the most significant gaps in each case are likely to be:

a. *A budget airline*

Gap 2 (the gap between management's perception of customers' expectations and the product specification): When first launched, one of the most significant challenges facing any low-cost airline is that of changing customer expectations to match the no-frills level of service that will be delivered.

Gap 5 (the gap between the customers' expectations and the customers' experiences): This could be a significant problem, particularly if customers expect the same type of flying experience and level of service as on a full-service airline.

b. *A traditional full-service airline*

Gap 4 (the gap between the customers' experience and the external communications to customers): Many customers' experience of flying often does not match the ideal portrayed in many of the adverts used by the full-service airlines.

c. *The latest computer game*

Gap 3 (the gap between the specification and the customers' experience of the product): There is a risk with all new products that they do not perform as designed. In this case, this might be due to a software bug or other computer glitch.

Gap 5 (the gap between the customers' expectations and the customers' experiences): There is a risk that the game fails to deliver the sort of experience expected by the player.

d. *An expensive watch*

Gap 1 (the gap between customers' expectations and management's perceptions of customers' expectations): This can be a risk with this type of product. For example, managers might believe that customers are looking for a watch with a highly technical specification and lots of features, when they might actually be more concerned with buying a watch that confers high personal status as a symbol of their wealth.

4. What would be the main costs of quality in the following organizations?

- a. **A motor car manufacturer**
- b. **A fast-food restaurant**
- c. **A hospital**
- d. **A hairdresser**

- a. *A motor car manufacturer:* Car manufacturers generally invest heavily in appraisal and prevention in order to avoid the high costs of internal failure (scrap and rework). However, the biggest quality cost is likely to be external failure. This includes the cost of product recalls, but the loss of reputation and future sales revenue is the most costly of all.
- b. *A fast-food restaurant:* Most restaurants tend not to spend hugely on appraisal and prevention, investing more in processes and staff training. The direct costs of internal failure are not likely to be that high. However, external costs might be high – dissatisfied customers inevitably lead to loss of reputation and falling sales.

- c. *A hospital:* Prevention costs in hospitals are mostly associated with the training of staff and ensuring operating procedures are rigorously applied. Appraisal costs have increased in recent years as more data is collected and assessed. Internal failure costs are most obviously reflected in longer patient stays. External failure costs are difficult to measure as they mostly consist of patient suffering. However, this might also manifest in law suits and loss of funding.
- d. *A hairdresser:* Hairdressers seem not to spend much on appraisal and prevention. Internal failure costs are very low. External costs mostly consist of future lost sales – but this can be very costly.

5. What are the advantages of using statistical process control (SPC) charts to manage quality?

What are the specific challenges of using SPC charts to manage these aspects of quality in the following operations?

- a. The size of a manufacture component
- b. The on-time arrival of trains
- c. The length of waiting lines in a theme park
- d. The time taken to answer the phone at a call centre

The main advantage of statistical process control (SPC) charts is that they use measurement to promote a proactive approach to quality, seeking to prevent defects occurring in the first place. Also, operator maintained charts encourage involvement in and ownership of quality by those most closely involved.

- a. *The size of a manufacture component:* This is the most straightforward use of SPC charts. The main challenges are associated with ensuring that the agreed sampling regime is operated correctly with measurements taken accurately, entered onto the charts, monitored and appropriate actions taken when necessary.
- b. *The on-time arrival of trains:* The main difficulty may be in determining the basis on which the sample of trains is to be selected. The other problem is that those doing the measuring are unlikely to be in a position to take action to rectify the causes of excessive delays.
- c. *The length of waiting lines in a theme park:* The challenge in this situation is to devise a sampling regime that will properly reflect the changing lengths of queues. These can be very dynamic and are likely to be subject to significant fluctuations at different times of the day.

d. *The time taken to answer the phone at a call centre:* Apart from the usual challenges of ensuring that the SPC charting is operated correctly, the biggest issue in this case may be whether this is the best measure of quality. Although customers will want their calls answered quickly, they will also want operators to fully answer their queries and with due courtesy. Measuring the time taken to answer calls risks operators truncating calls in order to answer the next call as quickly as possible.

6. A cutting machine has been set up to produce components with a specified length of 50 mm. Every hour during the eight-hour working day, a sample of four components is taken from the output of the machine and measured. The sample data are as follows:

Sample no.	Measurements (mm)			
1	50.0	49.5	50.5	50.0
2	51.0	49.0	49.0	49.5
3	50.5	49.5	50.0	51.5
4	49.0	50.0	51.0	50.5
5	50.0	51.0	50.5	49.5
6	50.0	51.5	50.0	49.5
7	50.5	51.0	50.0	50.5
8	50.5	50.5	50.0	49.0

Set up an SPC chart for means (X-bar) and ranges (R) for the process.

Sample no.	Measurements (mm)				X - bar	R
1	50.0	49.5	50.5	50.0	50.00	1.0
2	51.0	49.0	49.0	49.5	49.63	2.0
3	50.5	49.5	50.0	51.5	50.38	2.0
4	49.0	50.0	51.0	50.5	50.13	2.0
5	50.0	51.0	50.5	49.5	50.25	1.5
6	50.0	51.5	50.0	49.5	50.25	2.0
7	50.5	51.0	50.0	50.5	50.50	1.0
8	50.5	50.5	50.0	49.0	50.00	1.5

Process mean (mean of all X-bar values) = 50.14

X-bar chart UCL = $+(X\text{-bar-bar} \times A2) = + (50.14 \times 0.729) = + 36.55$

X-bar chart LCL = $-(X\text{-bar-bar} \times A2) = - (50.14 \times 0.729) = - 36.55$

Use these figures to set up the x-bar values process control chart (as per Figure 11.5).

Mean of all R values (R-bar) = 1.63

R-bar chart UCL = $D4 \times R\text{-bar} = 2.282 \times 1.63 = 3.72$

R-bar chart LCL = $D3 \times R\text{-bar} = 0$

Use these figures to set up the R values process control chart (as per Figure 11.5).

7. Should all organizations seek ISO 9000 accreditation?

ISO 9000 can have both operational and marketing benefits. In some industries, ISO 9000 certification is essential. However, in other industries other quality management systems are required. In particular, many large corporate purchasers insist that their suppliers operate to specific systems other than ISO 9000. For organizations that are not forced to comply with ISO 9000 or other quality management systems, the main operational benefits available from ISO 9000 are probably greatest for those organizations that do not have an existing quality management system or have poor quality records. There are many criticisms of ISO 9000; these tend to centre on its cost and its emphasis on bureaucracy rather than product quality and improvement. Critics of ISO 9000 have argued that it is least suited to service operations and small businesses.

8. What are the advantages and disadvantages to an organization of applying for one of the quality awards, such as the Deming Prize, the Malcolm Baldrige National Quality Award or the European Quality Award?

These awards afford both prestige and promotional opportunities to their winners. However, the act of entering for the awards can offer benefits in its own right by subjecting the organization to the rigor of the application process. Also, the models used by the various awards facilitate the quantification of an organization's quality practices and performance. This can help managers to

measure the impact of their quality efforts, enabling them to track quality performance over time and to compare themselves with other organizations. The main disadvantages are the associated costs of applying and the potential demotivational impacts of failure.

9. What are the advantages and disadvantages of the Six Sigma approach to quality improvement?

The main advantage of Six Sigma is that it provides a structured method for improving quality based on measurement against specific targets. Such quantification can not only guide quality improvement actions, but can also provide powerful motivation for those involved. Six Sigma can ensure that quality improvement actions focus on tangible actions rather than resorting to exhortations. Its disadvantages are associated with the costs of installing and operating what can be a quite complex process. In particular, there are likely to be high training costs. Also, most organizations are unlikely to possess the necessary expertise in-house and so will need to engage costly external experts. Six Sigma also requires a long-term commitment which is not always supported by some organizational cultures. Finally, the numerical goal of Six Sigma is all but impossible to achieve, which can prove somewhat demotivational.

10. In the process to manufacture a particular product, there are three different types of defect that can occur. A sample of 500 products is taken from the output of the process. A total of 35 products were found to be defective in one or more ways. There was a total of 55 defects. Calculate the defects per million opportunities (DPMO) figure for the process. What is the defect rate for the process?

$$\text{Proportion defective} = \frac{\text{No. of defects}}{\text{No. of units processed}} = \frac{35}{500} = 0.07 = 7\% \text{ defective}$$

$$\text{Defects per unit} = \frac{\text{No. of defects}}{\text{No. of units processed}} = \frac{55}{500} = 0.11 = 11 \text{ 0.11 defects per unit (DPU)}$$

$$\begin{aligned} \text{Defects per opportunity} &= \frac{\text{No. of defects}}{\text{No. of units processed} \times \text{number of opportunities}} = \frac{55}{500 \times 3} \\ &= 0.037\text{DPO} \end{aligned}$$

$$\text{Defects per million opportunities (DPMO)} = \text{DPO} \times 1,000,000 = 37,000$$

11. Can there ever be a universal model of quality management?

This is a complex and contentious issue. On the one hand, some argue that there are now a set of well-known and well-tried quality practices based on TQM that can be applied successfully in any operating context in any part of the world. On the other hand, others argue that operating context, and national cultural context in particular, make the universal application of those practices problematic. For example, even those Japanese corporations that developed and honed many of the most well-known quality practices have found them difficult to apply successfully outside of their home country and, consequently, have had to modify them for use in different parts of the world. It has often proved difficult to successfully apply the Japanese TQM models in Anglo-Saxon business cultures, which promote individualism and short time horizons. Although TQM can take many forms, all of these emphasize the importance of collective action and the necessity of pursuing quality improvement actions over very long time frames. These aspects of TQM often do not sit well with Anglo-Saxon cultures.

CHAPTER 12

1. **Compare and contrast the benefits and limitations of the scientific management and behavioural approaches to job design in the following different types of processes (see Chapter 6):**
 - a. **Mass production versus jobbing production**
 - b. **Mass services versus professional services**

Scientific management seems likely to be more applicable to job design in mass production and mass service processes. Jobs are more amenable to standardization, especially in mass production where specialist process technology is likely to determine the way the work is performed. However, there are some significant risks associated with the use of scientific management even in these processes. An insensitive application of its techniques can prove demotivational, alienating workers and thereby driving out their willingness to suggest improvements and respond to any variations or new situations. This can be particularly damaging in front office service operations if workers follow predetermined procedures rigidly and fail to respond to situations and specific customer requests which fall outside of the norm. The application of scientific management is much more problematic in jobbing production and professional service processes. These typically require workers to exercise more discretion to successfully undertake the work. The level of empowerment and autonomy required in these processes is more likely to be promoted by the application of behavioural approaches. Again, this is particularly the case in professional services, where the customer encounter typically requires a unique response and customer satisfaction is best achieved from worker commitment rather than attempts to control their behavior. It is arguable that even in mass production and mass service processes, the application of behavioral approaches is more likely to provide the levels of empowerment and initiative required in the complex and dynamic environment in which most operations have to function.

2. **The assembly of a particular component comprises four elements. The observed cycle times for each of the elements are listed below, together with a rating factor for each:**

<u>Element</u>	<u>Cycle time</u>	<u>Rating factor</u>
1	8.5	1.1
2	9.8	1.15
3	7.2	0.95
4	5.8	1.0

Assuming an allowance factor of 15 per cent, calculate the following:

- a. the normal time for each element;
- b. the overall normal time; and
- c. the standard time.

Normal time = Cycle time x Rating factor

Element	Cycle time	Rating factor	Normal time
1	8.5	1.10	9.35
2	9.8	1.15	11.27
3	7.2	0.95	6.84
4	5.8	1.00	5.80
Overall normal time			33.26

Standard time = Normal time x Allowance = 33.26 x 1.15 = **38.25**

3. Find a job that you are able to observe being performed in an organization that you have access to (e.g. as a worker or a customer). Use Hackman and Oldham's model to assess how likely it is that the current job design will deliver high levels of personal and work outcomes. Suggest ways in which the design of the job could be improved.

Clearly the assessment will depend on the job chosen, but it should be based on the application of the Hackman and Oldham model (see pages 369-371 in the book).

4. Discuss the claim that 'organizations should always pay their workers as little as possible'.

The argument that pay should be kept as low as possible is derived from the natural desire to minimize input costs. However, any organization's pay rates need to be competitive, at least within the labour market from which its workers are drawn, in order to attract and retain suitably qualified people. Whilst high pay is no guarantee of high performance, low pay rates are often associated with contributors to poor performance. Low pay is frequently equated by its recipients with low prestige and so can contribute to low levels of job satisfaction, which can lead to high absenteeism as well as high turnover. Also, low pay rates are often equated with low skill levels, and hence low productivity and low levels of flexibility in the workforce. Finally, workers will often take undesirable (but quite understandable) actions in order to increase their income. For example, they may seek to 'create' overtime opportunities.

5. Discuss the claim that 'people will always work harder for more money'.

The role of pay in motivation has long been a contentious issue. It is commonplace for organizations to link pay to performance. Whilst performance-related pay can motivate workers to increase output, this can sometimes lead to deterioration in quality or other aspects of performance. Sometimes performance-related pay schemes lead to other undesirable consequences, such as increased stress in workers leading to ill health and absenteeism. Also, performance-related pay schemes can be divisive between different groups of workers. In summary, the prospect of extra pay may motivate people, but not always to work harder in the ways envisaged by the designers of performance-related pay schemes. There is also a large weight of research evidence going back several decades that suggests that pay is not the only reward sought or achieved by people at work. Behavioural scientists have recognized this for many years. Abraham Maslow famously claimed that work meets a person's need for belonging, self-esteem and even self-fulfillment. David McClelland argued that work can satisfy a person's need for achievement. For many people, there is motivation enough in having interesting and challenging work.

6. Do you agree with the assertion that offshoring work from high to low labour cost countries is exploitation?

Typically, the whole point of offshoring is to reduce costs by taking advantage of low wage rates. Even if the offshore company pays wage rates that are higher than other employers in its locality, it is likely to be paying considerably less than in the home country. Some will see this as exploitation, perhaps also pointing to lost jobs in the home country. Others will see this as an inevitable consequence of globalization, which provides the benefits of jobs and economic development to the host country.

7. What are the advantages and disadvantages of the following types of teams:

- a. **A self-managed work team**
- b. **A cross-functional team**
- c. **A virtual team**

- a. *A self-managed work team:* The advantage of self-managed work teams is that they should lead to higher levels of motivation and job satisfaction, thereby improving performance. Such teams should be more autonomous and need less managerial control. The disadvantage is that workers need to possess a greater range of skills and in more depth, if such work teams are to be successful. Also, self-managed teams may not be suited to all organizational and national cultures.
- b. *A cross-functional team:* The advantage of cross-functional teams is that they bring together a wide range of expertise and viewpoints from different functional areas of an organization. They should help ensure that the team is better informed in its decision-making. The disadvantage is it can often prove difficult for people from very diverse backgrounds to work together successfully. This can be exacerbated if team members feel that they are in the team to represent their functions in some way, making for divided loyalties.
- c. *A virtual team:* The main advantage of virtual teams is that their use of ICT reduces or eliminates their need to meet face-to-face, thereby reducing the need to travel and enabling teams to draw upon members who would otherwise be unable to collaborate on the same task. The disadvantage of virtual teamworking stems from the limitations of electronically mediated

communications due to the absence of non-verbal signals and the lack of opportunity for social interaction. This can lead to misunderstandings, reduced job satisfaction and demotivation.

8. Using either Handy's or Deal and Kennedy's classifications of organizational culture, assess which type of cultures would be the best and worst environment for self-managed and cross-functional teams to operate in.

Self-managed work teams operate with a high degree of autonomy, taking decisions on such issues as the planning and controlling of work, the allocation of tasks to team members, the pace of the work, the evaluation of the performance of team members and the recruitment of new members. They are also likely to operate with a collective leadership rather than with a traditional supervisor. Cross-functional teams are composed of members from different parts of the organization. Such teams can experience additional problems if cultural differences exist between different functions. Teamworking seeks to replace managerial control with worker commitment and requires team members to be self-organizing and self-motivated. This seems more likely to be facilitated in Handy's task culture or Deal and Kennedy's 'work hard/play hard' culture.

9. Use Hofstede's dimensions of national culture to identify the kinds of countries in which self-managed work teams are more likely to succeed, and those in which they are more likely to fail.

Hofstede's four dimensions are: power distance, uncertainty avoidance, individualism versus collectivism and masculinity versus femininity. Self-managed teamworking is more likely to be promoted in cultures with:

Low power distance: If individuals are comfortable with the concept that power should be more equally distributed, this should help the team become more autonomous.

Low uncertainty avoidance: Self-managed teams need to be prepared to accept the risk and uncertainty associated with being empowered to make their own decisions and take actions.

Collectivism rather than individualism: By their nature, self-managed teams need to be comfortable operating collectively.

Femininity rather than masculinity: Teams need to value relationships between team members and show a concern for the quality of life of others.

10. View the websites of a number of different organizations (say, three or four) for the following information:

- a. What type of organizational culture is suggested by the information on display?**
- b. Assess the extent to which the organizational culture matches the home national culture of each organization.**

Your answers to this exercise will obviously depend upon the websites visited. To get the most out of the task, it is best to choose a diverse range of organizations in different industries and in different countries.

CHAPTER 13

1. Review recent media reports of operations discontinuities (there are always some!). Identify the main reasons for the failures. Do you think there is more that the product or service provider could have done to reduce the risk of such discontinuities?

Your answer will depend on the example chosen. To revise the topic of resilience (preventing failure), see pages 410-414 in the book.

2. What steps could the following types of organization take to (a) reduce the risks of, and (b) limit the impact of any discontinuities in their operations?
 - a. An airport
 - b. A university
 - c. A chemical manufacturing factory
 - d. A bank

Part (a) of the question is concerned with resilience, that is preventing failure in the first place. For each of the organizations, you should consider what actions could be taken to improve resilience in terms of:

- Process design,
- Redundancy,
- Fail-safing,
- Maintenance of equipment.

Part (b) of the question is concerned with risk mitigation, that is minimizing the effects of a disruption. For each of the organizations, you should consider what mitigation actions could be taken in terms of:

- Operational mitigation,
- Economic mitigation,
- Spatial containment,

- Temporal containment,
- Loss reduction,
- Substitution.

You should also identify the need for business continuity planning to ensure that the operation can be returned to normal as soon as possible.

3. What are the best ways of measuring failure for the following operations:

- a. University education
- b. Railway passenger transportation
- c. Airlines
- d. A retailer's website
- e. Hospital surgery

Failure is typically measured by:

- Failure rate: the frequency of failure, e.g.
 - the number of failures per operating hour,
 - the number of failures per unit sample size,
 - mean time between failures (MTBF).
- Reliability: the obverse of failure.
- Availability: the extent to which a process is available for work.

The best measurement for each of the operations listed is a matter of debate, but arguably:

- a. *University education*: Failure here is probably best measured in terms of drop-out rates (i.e. the percentage of students who fail to complete a course).
- b. *Railway passenger transportation*: Such operations may prefer to use a measure of reliability, probably relating to on-time departures.
- c. *Airlines*: Such operations may, like the railway, wish to use a measure of reliability for their flights. However, they may also use measures like mean time between failures (MTBF) or availability, when considering the reliability of their aircraft.

- d. *A retailer's website*: In this case, there may well be a preference for the use of a measure of availability. They might also want to use a measure related to MTBF.
- e. *Hospital surgery*: Measures here might be the rate of failure per patient treated. A 'failure' might be the surgery failing to cure the patient's condition, or, *in extremis*, the death of a patient.

4. Think of five examples of fail-safing that you have seen as a customer in a service operation. How effective is each one in preventing failure?

Your answer will depend on the examples chosen. For a reminder of what fail-safing involves, turn to page 411 of your book.

5. You are helping your friend to plan his or her wedding. Use the technique of FMEA to identify the most significant risks that need to be addressed so that they cannot spoil the day. What could be done to mitigate these risks?

Failure mode and effect analysis (FMEA) aims to identify and list all likely failure modes (i.e. things that could go wrong). For each failure mode, FMEA calculates a risk priority number (RPN). The higher the RPN, the more severe the risk. The RPN for each failure mode is calculated by assigning values (using a 1 – 10 scale) for:

- a. The severity of the effects of the failure.
- b. The probability of the failure occurring.
- c. The likelihood of the failure being detected.

The RPN is calculated by multiplying the values assigned to each of these factors together (see Table 13.1 in your book for an example).

Calculating RPNs enables the risks to be prioritized so that preventative measures can be drawn and focused on the most significant risks. You should be able to think of many failure modes for this exercise, likely including some rather hilarious ones.

6. Carpet manufacturing at Kozycarpets uses four processes in sequence: backing weave, tufting, edging and finishing. At present, a different machine conducts each of the processes. The reliabilities of the machines are 98 per cent, 83 per cent, 72 per cent and 65 per cent, respectively. The company can afford to buy one new machine to replace one of the old ones. The failure rates of the possible replacement machines are shown in the table.

Replacement machine	Failure rate (%)
Backing weaver	10
Tufter	16.7
Edger	33.3
Finisher	20

- How reliable is the present production line?
- Which of the existing machines would it be best to replace in order to maximize the reliability of the whole process?
- What would be the reliability of the revised production line you recommend?

a. Present reliability = $0.98 \times 0.83 \times 0.72 \times 0.65 = 0.38 = 38\%$

b.

	Machine reliabilities				
	Old machines	With new backing weaver	With new tufter	With new edger	With new finisher
Backing weaver	0.98	0.90	0.98	0.98	0.98
Tufter	0.83	0.83	0.83	0.81	0.83
Edger	0.72	0.72	0.72	0.67	0.72
Finisher	0.65	0.65	0.65	0.65	0.80
Line reliability	0.38	0.35	0.38	0.35	0.47

So, the best line reliability is with the new finisher.

c. With the new finisher, the line reliability would be 47%.

7. A product is made up of four components, A, B, C and D. The components can be purchased from three different suppliers with the following reliability ratings:

Component	Supplier		
	1	2	3
A	0.93	0.96	0.91
B	0.85	0.82	0.92
C	0.89	0.94	0.96
D	0.94	0.89	0.95

- What combination of suppliers should the company choose for maximum reliability?
- If the company wished to purchase all the components from a single supplier (to achieve bulk discounts), which should be chosen?

To identify the maximum reliability in combination, choose the highest reliability for each component:

Component	Supplier		
	1	2	3
A	0.93	<u>0.96</u>	0.91
B	0.85	0.82	<u>0.92</u>
C	0.89	0.94	<u>0.96</u>
D	0.94	0.89	<u>0.95</u>

Overall reliability = $0.96 \times 0.92 \times 0.96 \times 0.95 = 0.8055 = \mathbf{80.55\%}$

Reliability from a single supplier:

Component	Supplier		
	1	2	3
A	0.93	0.96	0.91
B	0.85	0.82	0.92
C	0.89	0.94	0.96
D	0.94	0.89	0.95
TOTAL	0.6613	0.6586	0.7635

Best overall reliability from a single supplier is from Supplier 3: $0.7635 = 76.35\%$

8. Review an example of a service failure that you have experienced as a customer. Do you feel more or less inclined to return to this service provider in the future?

Your answer will depend on the example. You might consider the way in which the organization attempted any service recovery action after the failure.

CHAPTER 14

- 1. For a customer service operation that you know well as a customer, construct a performance-importance matrix and identify the aspects of performance that it should concentrate its performance improvement activities on.**

Your answer will depend on the organization chosen but you should provide a justification for your assessment. For a reminder of the performance-importance matrix, see pages 427-428 in your book.

- 2. Compare and contrast the implementation challenges associated with the radical change and continuous improvement approaches to operations improvement.**

Radical change is designed to achieve a significant one-off improvement in performance, typically to be achieved by a major innovation that involves the use of new technology and/or new working methods. A major drawback in the step change approach is that it is 'top-down' in nature. As such, it has to be imposed on, or at best sold to, what may be a reluctant workforce. New technology will thus rely, at least initially, on external 'experts'. There is a risk that the people who will operate the technology in the long term will feel a sense of alienation from it. This is generally termed the 'not invented here' syndrome. There is no real commitment to use the technology to make it achieve the desired results. New technology will also inevitably involve the outlay of capital investment, which may be considerable. Further potential problems with new technology are listed on page 431 of your book. Given all these issues, it must be recognized that new technology is always a high-risk option.

Continuous performance improvement seeks to embed change into the organizational culture by making change the norm. Continuous performance improvement is driven from the bottom. It seeks improvement by tapping into the potential for innovation and creativity within the people that work for the organization.

3. Compare and contrast BPR and *kaizen* as methods of achieving performance improvement.

Business process re-engineering (BPR) is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as costs, quality, service and speed. It uses a step change approach to performance improvement that incorporates both new technology and new ways of working. Specifically, BPR aims to redesign business processes by incorporating advances in ICT alongside the new ways of working facilitated by the adoption of a process structure.

Continuous improvement (*kaizen*) is based on undertaking an on-going series of small incremental improvements. Continuous performance improvement involves a relentless pursuit of improvements, wherever and whenever they can be achieved. In contrast to step changes, which are driven from the top of the organization and are usually technology dominated, continuous performance improvement is driven from the bottom and is people dominant. Continuous performance improvement seeks to tap the potential for innovation and creativity within the people that work for the organization. In contrast to infrequent but dramatic step changes, the approach of continuous performance improvement seeks to embed change into the organizational culture.

4. The worksheet below lists all the steps that a firm currently uses to order stationery.

- a. Draw up a process activity chart for this.
- b. Suggest ways in which the process could be redesigned to speed up the process.

Worksheet for ordering stationery:

No.	Activity	Time (mins)	Actor
1	Obtain multipart stationery requisition form	2	Requestor
2	Open catalogue for reference number	0.5	Requestor
3	Complete multipart stationery requisition form	5	Requestor
4	Find envelope	0.5	Requestor
5	Write address on envelope	0.5	Requestor
6	Enclose stationery requisition form in envelope	0.5	Requestor
7	Send request of signature	0.5	Requestor

8	Wait in out tray	60	Requestor
9	Collect internal mail	0.5	Mail
10	Take to internal mail office	10	Mail
11	Wait until all mail arrives	30	Mail
12	Sort mail	20	Mail
13	Bundle mail for delivery	10	Mail
14	Wait until all mail ready for delivery	30	Mail
15	Deliver mail	0.5	Mail
16	Wait in in tray	30	Manager
17	Open envelope	0.5	Manager
18	Manager inspects request	1	Manager
19	Sign request	0.5	Manager
20	Change address on envelope to stationery	0.5	Manager
21	Send to stationery administration	0.5	Manager
22	Wait in out tray	60	Manager
23	Collect internal mail	0.5	Mail
24	Take to internal mail office	10	Mail
25	Wait until all mail arrives	30	Mail
26	Sort mail	20	Mail
27	Bundle mail for delivery	10	Mail
28	Wait until all mail ready for delivery	30	Mail
28	Deliver mail	0.5	Mail
30	Wait in in tray	30	Stationery
31	Open envelope	0.5	Stationery
32	Check authority and form details	1	Stationery
33	Place order on pick-list	0.5	Stationery
34	Wait for all orders to be processed	60	Stationery
35	Consolidate order and determine pick route	30	Stationery
36	Pick stationery items	60	Stationery
37	Bundle orders together	5	Stationery

38	Wait until all orders are bundled	60	Stationery
38	Add stationery costs to departmental budget record	1	Stationery
40	Wait while other order details entered	30	Stationery
41	Place white copy of order form for filing	1	Stationery
42	Send items to requestor plus blue copy of form	1	Stationery
43	(plus reorder form for out-of-stock items)		Stationery
44	Wait in out tray	60	Stationery
45	Collect internal mail	0.5	Mail
46	Take to internal mail office	10	Mail
47	Wait until all mail arrives	30	Mail
48	Sort mail	20	Mail
49	Bundle mail for delivery	10	Mail
50	Wait until all mail ready for delivery	30	Mail
51	Deliver mail	0.5	Mail
52	Wait in in tray	30	Mail
53	Use stationery to satisfy customer		Requestor

For a reminder of how to draw up a process activity chart, see page 442 in your book. You should be able to find several ways to improve the process using the BPR principles of ESIA:

- *Eliminating* all non-value-adding activities.
- *Simplifying* all remaining tasks as much as possible.
- *Integrating* tasks by combining two or more into one.
- *Automating* processes wherever possible through the use of the latest IT.

In particular, a move to online ordering would likely be beneficial.

5. Draw a process flow diagram for a process that you know well (this might be one that you have experienced as a customer, or one that you know through your work). Identify opportunities for process redesign that would improve its performance.

Your answer will depend on the example chosen. To revise process flow diagrams, see pages 443-444 in your book.

- 6. Draw a service blueprint for a customer service operation that you experienced as a customer. Use the service blueprint to identify possible points of service failures and their causes.**

Your answer will depend on the example chosen. For a reminder of service blueprinting, see page 444 in your book.

- 7. Think of a product or service that you have recently experienced that has failed to meet your expectations in some way. Draw a cause and effect diagram to identify all the main causes of the failure that you experienced.**

Your answer will depend on the product or service chosen. For an example of a cause and effect diagram, see page 447 in your book.

- 8. Find at least one example of each of three Mathe and Perras (1994) generic learning processes for companies expanding their operations globally.**

Mathe and Perras (1994) identify three generic learning processes:

- Following existing customers and learning from them.
- Buying local operations or cooperating with a local service provider.
- Going it alone and learning from the experience.

You should look for recent examples from the business press or from your own experience.

CHAPTER 15

1. What are the advantages of being first to market with a new product or service?

The main advantages of being first to market are:

- *Increased market share:* Organizations that bring new products to market first can establish market share more easily than slower competitors; this can ensure their long-term profitability.
- *Price premiums:* Being first to market enables the organization to charge premium prices, at least until such time as competitors are able to enter the market.
- *Faster response to competitors:* If an organization has built a capability in fast NPD, it will be better placed to respond if it is taken by surprise by a competitor's introduction of a new product.
- *Setting industry standards:* For revolutionary products, the first to market is often able to set the standards for that industry. This can then act as a significant barrier to entry for competitors, especially if their product is based on an alternative technology.

2. Visit a website that you are familiar with, perhaps one that you use for shopping (e.g. www.amazon.com) or one that provides you with information (www.cnn.com). Does the site represent an example of good design?

You should use objective criteria in making your assessment. For example, the chapter lists the following which are relevant:

- Aesthetically pleasing
- Satisfies customer needs
- Meets customer expectations
- Performs well
- Reliable

3. New products can be incremental products, next-generation products or breakthrough products. Give three examples of each type.

You should be able to find plenty of current examples to cite. To revise the new product categories, see pages 464-465 in your book.

4. What are the advantages and disadvantages of using a structured multistage process for developing new products?

The advantage of using a structured multistage process is that it should improve the chances of success of a new product once it is launched into the market. Those that make it through should be sufficiently well-developed and tested so as to minimize the risk of costly failure in the marketplace. Using a series of clearly established criteria at each stage of the NPD process should ensure that products likely to fail can be aborted, thereby avoiding further spending that seems likely to be wasted. The organization can then ensure that its scarce resources are concentrated on developing products thought to have the best chances of success.

There are two significant drawbacks in using such a structured process for NPD, however. Firstly, there is the risk that good ideas might be rejected. Organizational decision-making is often not the objective, rational process it is sometimes depicted as. It can be faulty due to inadequate information, a failure to adequately consider the information, individual prejudices and organizational politics. It is not unknown for one organization to reject an idea which is subsequently turned into a commercial success by another. The other problem is in the time taken in following a rigid multistage process. The longer it takes to bring a new product to market, the greater the likelihood that a competitor will get there first.

5. Why should new products and the processes that will produce them be developed at the same time?

Designing processes alongside products should help ensure that the products can be more easily manufactured. This will also reduce production costs and improve product quality. Designing the process at the same time as product design should additionally reduce the total time to market, by helping eliminate production problems at source. This system should help avoid either having to

make unforeseen investments in the manufacturing plant or making costly and time-consuming changes to the product design.

6. To what extent is the development of new services different from the development of new products?

In many respects the new service design process is the same as that for new product design. However, new service design has one important additional issue; namely that of the involvement of customers. Front office services involve customer contact; this needs to be considered in the new service design. Any new service is likely to involve a new experience for customers. They may well not know what is expected of them, at least on their initial contact with the service system. Whilst it is commonly understood that new employees need to be trained to deliver a service, the need to train customers to receive the service often remains unrecognized. Customers who do not know how to behave appropriately, or who do not know how to operate self-service technology, are not only likely to have an unsatisfactory experience of the service, but are also likely to diminish the experience of those customers who do possess the relevant knowledge and skills. Service designers need to assess the knowledge, skills and attitudes likely to be possessed by prospective customers. Where these fall short of those required for the successful operation of the service delivery system, then steps need to be taken to provide customers with the necessary education and training. This is likely to involve clear signage and operating instructions in appropriate languages and probably pictures as well. It is also likely to require extra staff being made available to customers, at least in the early stages of their use.

7. To what extent can digital music downloading from the Internet be seen as a disruptive technology?

Music downloads via the Internet have certainly been disruptive for the music industry, with record companies blaming the falling sales of CDs on this new distribution channel. Whether this amounts to a disruptive technology in the terms of Clayton Christensen's model is another question. He argues that disruptive innovations typically lead to the introduction of products and services that are initially not as good as those currently available. Consequently, they tend to appeal to new or less-demanding customers, as their products are simpler, more convenient and less expensive. Music downloads were certainly this as far as new, young and ICT savvy music lovers were concerned. It

was amongst this market that music downloading took off. Whether the music companies' response of suing the downloaders was sensible is a mute question. However, the large numbers of such users encouraged the downloading services to initiate a series of improvements which attracted more and more users. These are still continuing and the disruptors have triumphed. The music companies have now, somewhat belatedly, recognized the importance of download technology and are finally embracing it. Thus, Christensen's model does arguably apply in this case.

8. What are the advantages of concurrent design? What organizational arrangements are most likely to support this approach?

(Concurrent design is sometimes called the rugby scrum approach.) Concurrent design is based on the use of multi-functional teams of members from relevant departments (Design, Operations, Sales, etc.). The advantage of this is that it helps break down departmental barriers and ensures that the concerns of different departments are taken into account in the design process. Involving people from other departments also helps ensure that these issues can be dealt with at an early stage in the development process. Also, work on different aspects of the project can be progressed simultaneously without waiting for full completion of the others. This helps speed the design process and improve the final design. A number of organizational arrangements can be used to support concurrent design. These include:

- *Matrix structures:* Where workers remain in their departments but their efforts are coordinated by a project manager liaising with their functional manager.
- *Task forces:* Where a dedicated project manager brings together workers from different departments, who are seconded to the project as and when they are needed.
- *Project teams:* Where the project has its own team of workers and managers, dedicated solely to the work of the project for its duration.

9. Explain how the techniques of DFM, QFD, and VE can be used to improve new product development.

Design for manufacture (DFM) is a technique where process design is considered alongside product design. This helps ensure that products are designed so that they can be produced most easily and economically.

Quality function deployment (QFD) is a structured procedure that aims to ensure that product design meets the needs of the customer. It does so by forcing designers to match each customer requirement from the product with the way that the design parameters meet those requirements.

Failure mode and effect analysis (FMEA) is a systematic technique that seeks to identify the cause and effect of product failures. It is based on a risk assessment of all possible causes and consequences of failure.

Value engineering (VE) is a design technique that seeks to reduce the cost of a product whilst not affecting its value and performance from the perspective of the customer.

10. What is the difference between a research-oriented and a development-oriented organization? How do these differences affect their choice of locations for their R&D activities?

Research-oriented organizations have the ability to develop technology and to generate streams of innovations from their own research. They tend to keep their research units centralized. Their main concern in choosing a location is to secure high-quality research and staff.

Development-oriented organizations have the ability to exploit and apply technology to products and processes. They tend to decentralize their development units in order to minimize internal and external transfer costs. Development units are therefore often located within operations units, in order to improve learning about markets and key customers.

CHAPTER 16

1. What aspects of operations management are most affected by increasing internationalization of business?

Most, if not all, aspects of operations management can be affected by the increasing internationalization of business. Some examples are listed below under the categories of the operations management key decision areas model adopted for the structure of this book:

- *Facilities*: Country location decisions.
- *Capacity*: How to manage the productive capacity of organizational facilities to meet demand in a number of different countries.
- *Process technology*: Technology transfer decisions between one country and another.
- *Supply network*: International sourcing decisions.
- *Planning and control*: Matching demand from different countries when supply is sourced in others.
- *Quality management*: Managing national differences in approaches to quality management.
- *People in OM*: Organizational structure decisions in international businesses; managing national cultural differences; recruitment and selection, training and development, job design, reward and remuneration decisions in international organizations.
- *Operations improvement*: Benchmarking operations in different countries.
- *Innovation*: Managing the NPD process to meet the requirements of customers in different countries; coordinating NPD activity in different countries.

2. Is it inevitable that in the future all manufacturing operations will be carried out in low labour cost countries?

It may be inevitable that some manufacturing operations will always migrate to low labour cost locations. Such locations will always favour labour-intensive operations that require relatively low levels of skill and are easily transferable. However, although low manufacturing costs are generally desirable, not all companies compete solely on the basis of price. The business

strategies of some companies require their operations to compete on the basis of other performance objectives (quality, flexibility, dependability and speed). The pursuit of these performance objectives may not be best supported by locating operations in low labour cost destinations. Also, as relative labour costs between countries change over time, organizations seeking low-cost labour are likely to be faced with having to continually move their operations from one location to another. This has associated costs that may be significant. Any gain from reduced labour costs clearly needs to be offset against the potential additional costs from the disruption and start-up costs of operating in a new location.

3. To what extent can producers of goods and services continue to move their locations in pursuit of the lowest labour costs for their operations?

Producers will always want to achieve the lowest unit labour costs. However, labour costs are only one consideration in choosing a location for facilities. For example, reduced labour costs may need to be offset against higher transportation costs for getting raw materials into a factory and finished goods to market. Organizations that are always seeking the lowest labour rates are likely to be faced with having to continually move their operations from one location to another. Assuming that new locations with suitably low wage costs can be found, there is a significant challenge in having to manage such new investments. Opening new facilities creates start-up costs, not only in terms of the process technology, but also in terms of workers, who have to be recruited, trained and organized to operate and maintain that technology. Similarly, expertise in planning and controlling, managing quality and other aspects of operations management need to be developed at any new location. In any new situation, it is likely to take longer to develop the necessary organizational learning skills which can form the basis of future capabilities. Setting up new facilities implies creating new supply arrangements or, at best, disrupting existing arrangements. Any gain from reduced labour costs clearly needs to be offset against the potential additional costs from the disruption and start-up costs of operating in a new location. Opening new facilities may also imply closing down or downsizing existing facilities which may also be costly.

4. What aspects of operations management are most affected by the trends towards more outsourcing?

Increased outsourcing primarily affects supply network issues within operations management. The greater use of offshoring typically causes a physical lengthening of the supply chain, making it more vulnerable to disruption. The adoption of lean supply principles exacerbates this vulnerability, increasing the difficulty of integrating suppliers' operations into the organization's own supply network. The challenge of integration in particular raises challenges for planning and control and quality management. The difficulty can only be increased if suppliers are located in another country.

5. Identify at least three examples of how organizations are using Internet-based digital technology to radically change their operations.

There should be many examples that you can draw on as the digital revolution proceeds. These might include the online booking of services as diverse as travel, financial services and government services, as well as online retailing.

6. What actions might the following types of organization take to reduce the carbon footprint of their operations:

- a. An airline
- b. A steel manufacturer
- c. A bank
- d. A car-hire firm

Actions might include:

- a. *An airline*: Flying more fuel-efficient airplanes, minimizing the number of flights operated, maximizing seat capacity utilization (to minimize carbon usage per passenger).
- b. *A steel manufacturer*: Operating a fuel-efficient plant, sourcing electricity suppliers from renewable generators, minimizing the distance travelled by its raw materials and finished products, using less carbon-polluting forms of transport for raw materials and finished goods.
- c. *A bank*: Switching to online services as much as possible, minimizing paper-based communications internally and externally, operating energy efficient offices.
- d. *A car-hire firm*: Running fuel efficient cars, switching to non or low carbon fuels where possible.

7. What are the most important ethical issues currently affecting the operations of the following types of organizations:

- a. **Pharmaceutical manufacturers**
- b. **Clothing retailers**
- c. **Fast-food retailers**
- d. **Out-of-town superstores**

Issues might include:

- a. *Pharmaceutical manufacturers:* Animal testing, product pricing in developing countries, stem cell research.
- b. *Clothing retailers:* Sourcing from suppliers in low-wage, poorly regulated countries, use of animal-derived raw materials in products (e.g. furs).
- c. *Fast-food retailers:* Causing obesity, provision of low-wage jobs, the environmental impact of suppliers' activities (e.g. forest clearance for beef production) and transportation of raw materials.
- d. *Out-of-town superstores:* Market dominance and predatory pricing forcing smaller rivals out of business, pressurizing suppliers on price, sourcing from suppliers in low-wage economies, use of scarce greenfield land, carbon footprint of transportation of goods to stores.

8. What do you think will be the biggest issues to affect the following types of operations in five years' time?

- a. **Food manufacturing**
- b. **Healthcare**
- c. **Aircraft manufacture**
- d. **Retail banking**

This is something of an exercise in 'crystal ball gazing', requiring some degree of imagination. You should try and justify your prediction. It might be interesting for you to compare your list of predictions with the list of emerging issues identified in the chapter (low-cost labour, population changes, discontinuities, environmentalism and social responsibility).

9. **Select an organization that you know well or one that you can readily access information about. Using the ideas in Hayes' (2002) article (as summarized in this chapter), assess the extent to which the organization has adapted its approach to operations management because of the impact of the Internet on its activities.**

Your answer will depend upon the example chosen. For a reminder of the ideas in Hayes' (2002) article, see pages 501-505 in your book.