RON BASU • J NEVAN WRIGHT

TOTAL SUPPLY CHAIN MANAGEMENT

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Ron Basu and J. Nevan Wright

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To Moria, Bonnie and Robi

R.B.

To Joy, Michael, Paul, Bruce, Daralyn and Tim

J.N.W.

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Contents

Note each chapter is designed to stand on its own. Therefore some duplication of content has been inevitable and where applicable some cases and examples are re-visited.

Preface

Touring India with my son Robi in April 2006, our plan was to follow the series of one day international cricket matches between England and India. I took this opportunity to meet my contacts there, one of whom, Soumen Mukherjee of my Indian publishers Elsevier, suggested that it might be an idea to have an updated supply chain management book including an Indian version. His feedback from academics and practitioners in India suggested that current volumes covering this topic were primarily centred around Western (US and European) manufacturing businesses, as well as being mostly of a rather heavy, academic nature. I promised him that I would think about his proposal.

After consideration, I realized that supply chain management is now both global and dynamic as well as facing many challenges of the twenty first century. These are: the impact of the Internet and e-businesses; globalization and outsourcing; environmental and green issues; challenges from emerging economies such as India and China; challenges of the large service sectors; the pitfalls in supply chains in major projects and so on.

I prepared a draft proposal and discussed my thoughts with my ‘partner in crime’ Nevan Wright who supported and enhanced my ideas. The outcome is this book.

We have tried to develop this project bearing in mind the way we would have liked a book to meet our requirements. Thus each chapter is supported by appropriate case examples. We have made an attempt in the final chapter to put together most aspects of supply chain building blocks using simple case studies.

This book is aimed at abroad cross-section of readership including:

- Functional managers, participants and practitioners in supply chain management will find this book will provide them with a comprehensive insight into the basic building blocks of supply chain management and the new trends and challenges.
- Senior Executives, both in the manufacturing and service industries (regardless of function) and Senior Project Managers will find that this book will give them a better understanding of the holistic approach of total supply chain management in the midst of globalization, outsourcing and multiple levels of suppliers.
- Management schools and academies and research associations will find this book valuable to fill the visible gap in basics of supply chain management. This text will provide support to both undergraduate and post-graduate courses containing supply chain and operational excellence and as a main textbook for MBA students.

- The readership will be global to cover North America, UK, Continental Europe, Australia, New Zealand and Asia Pacific countries. The special edition for the Indian subcontinent will offer easier and more affordable access to readers in the region.

We hope that the enjoyment we have had in writing this book will be echoed in the reader's experience, and trust that they will find it instructive and useful.

Ron Basu
Gerrards Cross, England
May 2007

Acknowledgements

As always it has been my pleasure to work with my co-author Nevan Wright.

I acknowledge the help and support from my colleagues and students at Henley Management College in England and ESC Lille in France. I am also grateful to Professor Manab Pal and his colleagues in the Indian Institute of Management in India for their valuable contributions.

My sincere thanks go to the staff of our publishers, Elsevier, especially to Maggie Smith in the UK and Soumen Mukherjee in India.

Finally, the project could not be completed without the encouragement of my wife Moira and daughter Bonnie.

Ron Basu

Once again I have enjoyed working with Ron. Although we split the number of chapters fairly evenly, and edited each other's work, for this book Ron has been the lead author and driving force. As always I acknowledge the support of Joy, my best friend (and wife).

Nevan Wright (Auckland, NZ)

About the authors

Ron Basu is Director of Performance Excellence Limited and also a visiting Executive Fellow at Henley Management College. He is also a visiting Tutor of Lille Graduate School of Management and Essex University. Previously he held senior management roles in blue-chip companies like GSK, GlaxoWellcome and Unilever and worked as a Management Consultant with A.T. Kearney.

Dr. Nevan Wright is a member of the professoriate of Auckland University of Technology (New Zealand), a visiting Academic Fellow of Henley Management College (UK) and a Fellow of the New Zealand Institute of Management. Prior to joining academia Nevan was a Director/General Manager of several large manufacturing companies in New Zealand. Earlier he had served 9 years as a commissioned officer in the New Zealand Air Force.

Ron and Nevan are the authors of

Total Manufacturing Solutions
Quality Beyond Six Sigma
Total Operations Solutions
La Calidad Mas Alla Del Six Sigma

Ron is also the author of
Implementing Quality

Nevan is the author/co-author of
The Management of Service Operations
Management of Event Operations

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1

The role of supply chain as a value driver

Introduction

In this chapter, the basic concepts of supply chain management are explained. It is shown that supply chains in some shape or form are required to deliver products and services we, or our organization need, or think is needed.

For every business transaction there is a supplier and a customer and there are activities, facilities and processes linking the supplier to the customer. The management process of balancing these links to deliver best value to the customer at minimum cost and effort for the supplier is supply chain management. You will experience supply chains everywhere, for example in running your home, managing a manufacturing business, in health services, hotels, banks, government, utilities, non-profit organizations, universities, entertainment, retail and professional services. From the cradle to the grave there will be supply chains involved.

Supply chains vary significantly in complexity and size but the fundamental principles apply to all operations whether they be large or small, manufacturing or service, private or public sector. Supply chain management is not just for large big name businesses such as Dell Computers, Wal-Mart and Toyota Motors. It is for all businesses and for all operations.

When Moira and Joy (our respective wives), visit a hairdresser they are the customer and the hairdresser is the supplier. The hairdresser will have to ensure the availability of materials (shampoo, conditioner and colouring), facilities and equipment (e.g. chairs, driers, etc.). The hairdresser in order to provide the service is involved with purchasing, inventory management and facilities management. In order to minimize customer queues there is also a need for demand forecasting, capacity management, scheduling and quality management. In this example of a basic service operation we can identify the key components of supply chain management.

Take another example. Consider that you are checking in at Zagreb Airport for a return flight to London. You are unhappy to find a long queue. You have discovered that in addition to normal procedures the central computer was down and a screening machine was installed to X-ray all types of luggage as an extra security precaution. In this case, the supply chain is obviously more complex than the hairdressing service. For you the customer the initial focal point is the check-in clerk, but there are many supporting links leading to this service. The airlines have to sell tickets, ensure the availability of aircraft with all the required fittings (including in flight entertainment systems) in an acceptable condition, provide meals and have a stock of trained aircrew available. Before you got to Zagreb Airport our administration manager will have purchased a ticket from a travel agent who in turn may have made an electronic booking. In this example, there are suppliers and suppliers of suppliers and there are customers and customers of customers. However, the basic functions of forecasting, capacity management, inventory management, scheduling and quality management are present just as they were with the hairdresser, and just as they are for any supply chain.

The key objective of supply chain management is to provide best value to the customer by measuring, planning and managing all the links in the chain. When Joy or Moira receive a hair style as per her requirements (specification) and at an affordable price in pleasant surroundings from a helpful and skilled hairdresser she will consider that she has received good value service. With a coiffure (French for hair cut) the perception of whether a service is good or not can be very subjective. Joy might have said what she wanted, and the hairdresser has faithfully carried out her instructions, but once 'madam' sees the end result she could well be dissatisfied. Not all aspects and outputs of a supply chain can be precisely measured!

What is supply chain management?

In a typical supply chain, raw materials are procured and items are produced at one or more factories, shipped to warehouses for intermediate storage and then shipped to retailers or customers. If you asked people involved in business to define the term supply chain you would get many different answers. Each definition would reflect the nature of the business and the inputs and outputs produced. For some, supply chain is related to purchasing and procurement, to others it is warehousing, distribution and transportation. Yet for others it would be sources of capital and labour.

Melnyk and Swink (2002) provide a holistic definition of the supply chain which is the entire network of organizations involved in:

1. converting raw materials and information into products and services,
2. consuming the products and services,
3. disposing of the products and services.

They further state that 'this definition treats the supply chain as a product cradle-to-grave concept, including all value-added activities required to plan, source, make and deliver products and services that meet customer needs'. To this we add the word process. We see the supply chain not as a series of separate operations and organizations but as a complete end-to-end process.

Another useful definition is provided by Simchi-Levi et al. (2003, p. 1)

> *Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements.*

What do these definition suggest? They suggest that supply chain management must consider every organization and facility involved in making the product and the costs involved in doing so. This also implies that the objective is to be cost effective across the whole supply chain, which requires a system-wide approach to optimization.

Supply chain in manufacturing

Supply chain management in a manufacturing and supply organization considers demand, supply and inventory needs for each item of production and in particular looks at how inventory flows through the system to achieve output to the customer's specification on time and at least cost. With supply chain management, customer service is increased through the reduction of lead times and the product is always exactly as specified and it is always delivered on time. In Chapter 19, we describe this as the delivery of a 'perfect order'. Costs are reduced through the elimination of any activity that does not add value and through the reduction of inventories of material and associated holding and handling costs.

Activities and measures based on customer requirements, as explained in Chapter 4, are very important in improving business performance. But externally driven customer-based measures have to be matched by measures of what the company can do (feasibility, capacity, know how and resources) to consistently meet customer expectations. A high standard of customer performance derives from planning, processes and actions integrated across the whole organization.

Supply chain management focuses on the critical measures of all elements of the supply chain. Externally the measures include the suppliers at one end and the customer at the other end of the supply process. These externals, the supplier and the customer, are matched with the internal requirements of the manufacturing process. The focus is twofold; to satisfy customer needs and to keep costs to a minimum.

In reality the elements of supply chain management are not new – we all have been managing parts of the supply chain for years (e.g. buying, planning, scheduling, stock control, warehousing, logistics, distribution, etc.) without realizing the significance of the whole chain concept. Likewise, the cost of the various elements of supply and distribution has been long recognized. 'In 50 years between 1870 and 1920 the cost of distributing necessities and luxuries has nearly trebled, while production costs have gone down by one fifth – what we are saving in production we are losing in distribution' (Ralph Barsodi, 1929).

It is relatively new to view the supply chain as a process, that is a single integrated flow across all the functions of the business. Traditionally activities within a supply chain were seen as separate and specialist functions such as purchasing, planning, scheduling, manufacturing and distribution. With supply chain management the flow of materials and flow of information across traditional functional boundaries is seen as a single process. These flows are depicted in a simplified model in Figure 1.1.

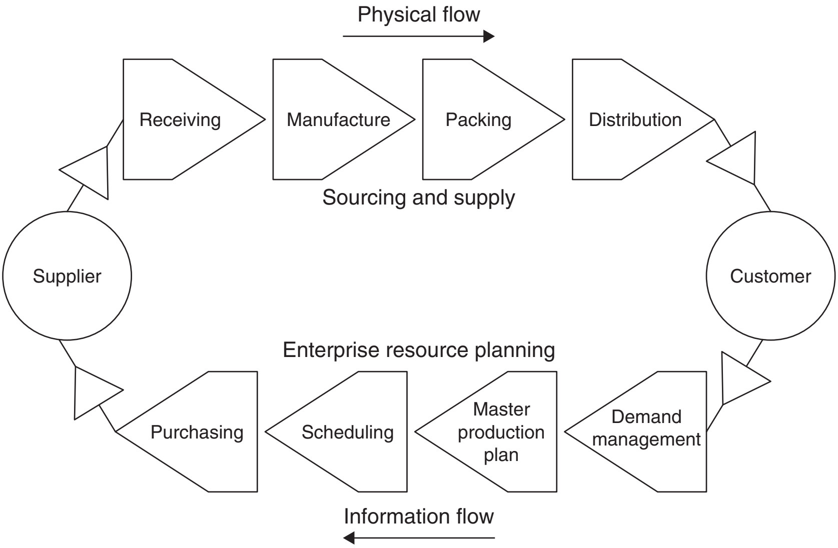

Figure 1.1 Supply chain management.

In the past information flow was the domain of the commercial division while the conversion process of materials flow was a manufacturing or technical division responsibility. With an integrated supply chain approach the responsibility for all elements of supply is now with operations management or supply chain management. In many businesses, the integrated approach is being extended to include all suppliers (including ‘upstream’ first, second and third tier suppliers) through the manufacturing process ‘downstream’ to each level of customer (including distributors, wholesalers and retailers through to the end user or consumer). This is known as the extended supply chain.

Supply chain in services

Thanks to ease of travel, the media and the ‘World Wide Web’ customers have never been more informed than they are today. Customers know what they want and know what can be done, they understand the concept of world class and continuous improvement. This is especially true in service industries. As a result of the heightened expectations of customers, operations managers in service sectors have been forced to focus their attention on managing the complete value-adding system using the principles of supply chain management.

But how can service industries apply supply chain management? The supply chain of a service organization contains suppliers, products or services, customers and their demand for products and service level agreements. Service inventory can be in the form of information databases, stocks of consumables (as with the hairdresser), stationery items (including brochures and promotional material) and subcontractors (including facility managers, travel agents, caterers and advertising agencies).

Swank (2003) described a successful application of supply chain management and lean production principles in a typical insurance service company in the USA; Jefferson Pilot Financial (JPF). JPF believed that the processing of their almost tangible 'service product' was comparable to a car assembly process. Swank explains that 'Like an automobile on the assembly line, an insurance policy goes through a series of processes, from initial application to underwriting or risk assessment to policy issuance. With each step value is added to the work in progress – just as a car gets doors or a coat of paint'.

Supply chain in not-for-profit organizations

The good practices of supply chain management can be adapted to provide major practical benefit to not-for-profit organizations, such as charity organizations, in meeting their objectives. International disasters have a huge impact on the world's population, increasing the need for aid organizations to improve their logistics capability and capacity. Perhaps the biggest impact of supply chain management in not-for-profit organizations is responding to unpredictable demands through quick response supply and distribution.

The world events of 2005 have insinuated that humanitarian organizations are yet to fully exploit supply chain optimization. For example, referring to the Hurricane Katrina disaster in New Orleans, Waller (2005) was not surprised that Wal-Mart, the world's largest retailer, beat the Federal Emergency Management Agency (FEMA) and the Red Cross to areas devastated by the hurricane. He said the company delivered supplies quickly and efficiently because that's what it does every day. Wal-Mart is the master of supply chain management and the company's expertise in this area worked well during a natural disaster. How Wal-Mart was able to do this is further explained in Chapter 10.

An example of the application of supply chain management in a not-for-profit organization is the National Health Service (NHS) in the United Kingdom.

UK National Health Service: Excellence in supply chain management

The NHS in the United Kingdom spends £15 billion annually on purchased goods and services. It was determined that there was enormous potential for NHS organizations to save money through effective purchasing. As a result, the NHS Purchasing and Supply Agency (PASA) was established in 2000 as a significant part of the government's modernization of NHS procurement activities to act as a strategic adviser to the NHS on all supply issues. The primary goal of PASA is to improve the performance of the NHS purchasing and supply system and become the centre of expertise, knowledge and excellence in purchasing and supply matters of the NHS for the benefit of patients and the public.

Some of the achievements of PASA include:

- Achieved savings for the NHS totalling £580 million over the 3-year period of April 2000–2003.
- Implemented pilot supply 'confederations' as recommended in the May 2002 policy document 'Modernizing Supply in the NHS' to develop a middle tier between national (PASA) and local (individual NHS trust) level purchasing.
- Produced an e-commerce strategy for the NHS through the development of an e-procurement toolkit, which provides a framework to help NHS trusts and confederations understand the benefits of e-procurement and plan its implementation in a structured way.
- Developed a national set of purchasing and supply performance management measures to better assess the performance of NHS trusts with respect to supply chain activities through benchmarking analysis and strategic assessment of trust and confederation spending.

Source: National Health Service, UK (2004).

What about logistics management?

Is there a difference between 'logistics' and 'supply chain' management? The Council of Logistics Management has recently changed its name to Council of Supply Chain Management Professionals, which indicates that they see logistics management as part of the supply chain process. The council when still the council for Logistics Management defined logistics management as:

The process of planning, implementing and controlling the efficient, cost effective flow and storage of raw materials, in-process inventory, finished goods, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements.

There new definition is 'Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers and customers. In essence, supply chain management integrates supply and demand management within and across companies.'

Council of Supply Chain Management Professionals (2007).

If we consider these definitions we see they are very similar to the earlier definitions we have provided (Melwynk and Swink, 2002; Simchi-Levi et al., 2003), and can conclude that for our purposes, at least in a manufacturing and supply organization, logistics and supply chain management are synonymous. If one is inclined to separate the physical movement of logistics in a service organization, we can see that there is but a fine border between logistics and supply chain management in the service sector.

Taylor (1997) goes on to divide supply chain management into:

- Logistics and supply chain strategy
- Purchasing and supplies management
- Manufacturing logistics
- Distribution planning and strategy
- Warehouse planning and operations management
- Inventory management
- Transport management
- International logistics and international market entry strategies

Taylor's definition infers that 'Logistics' is a subset of 'SCM'. Each sub-topic contributes to the performance of the overall supply chain process and, as a consequence, to improved stakeholder satisfaction.

What are inbound and outbound logistics?

The flow of information and physical goods from both customers and suppliers to the business or the conversion centre (e.g. a factory or a warehouse or an office) is termed as inbound logistics. Likewise, the flow of information or goods or service from the conversion centre to the customer constitutes outbound logistics. To put it more simply inbound logistics relate to demand and procurement while outbound logistics relate to supply and service.

Figures 1.2 and 1.3 show examples of inbound and outbound logistics in a foods factory.

Demand and supply planning capabilities enable companies to balance inbound and outbound logistics and thus to maximize return on assets, and to ensure a profitable match of supply and demand. Inbound and outbound logistics are also described, as upstream and downstream processes. For example, Christopher (1992) defines supply chain management as the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole.

What is e-supply chain?

As shown in Figure 1.1, the traditional supply chain was concerned with a linear flow of information and products/services from customers to suppliers

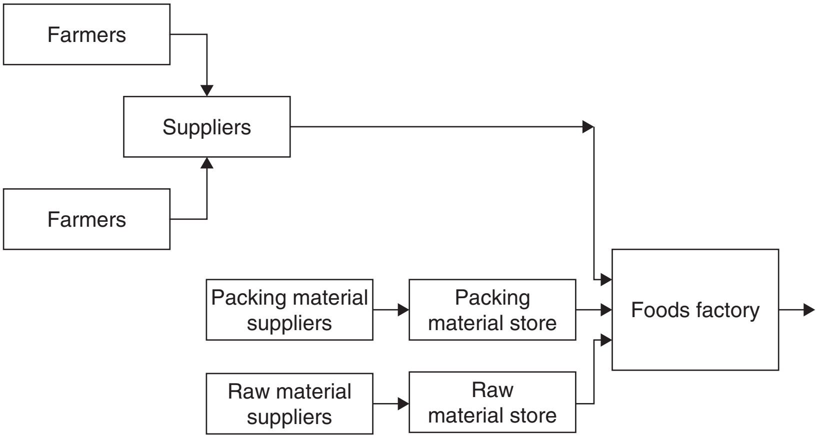

Figure 1.2 Inbound logistics: Foods supply.

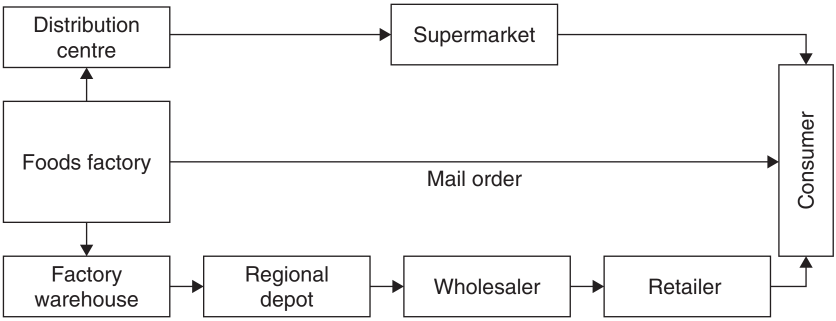

Figure 1.3 Outbound logistics: Foods supply.

through various stages of processes while the information flow was the domain of the commercial division and the conversion process of materials flow was a manufacturing or technical division responsibility. During the 1990s, the concept of total supply chain management shifted the responsibility for all elements of supply to operations management or supply chain management.

According to Basu (2002) the Internet-enabled integrated supply chain or e-supply chain has extended the linear flow of the supply chain to an Ecosystem or a supply web (see Figure 1.4). It now includes all suppliers and customers to the end user or consumers suppliers' customers and customers' suppliers and so on. The front runners of the new collaborative business model, such as Dell and Toyota are sourcing materials and products in response to customer demand and minimizing both inventory and dealers. The collaborative culture has enabled these companies to become adept at managing relationships between customers, suppliers and multidisciplinary company functions with a sharing of transparent information and knowledge exchange.

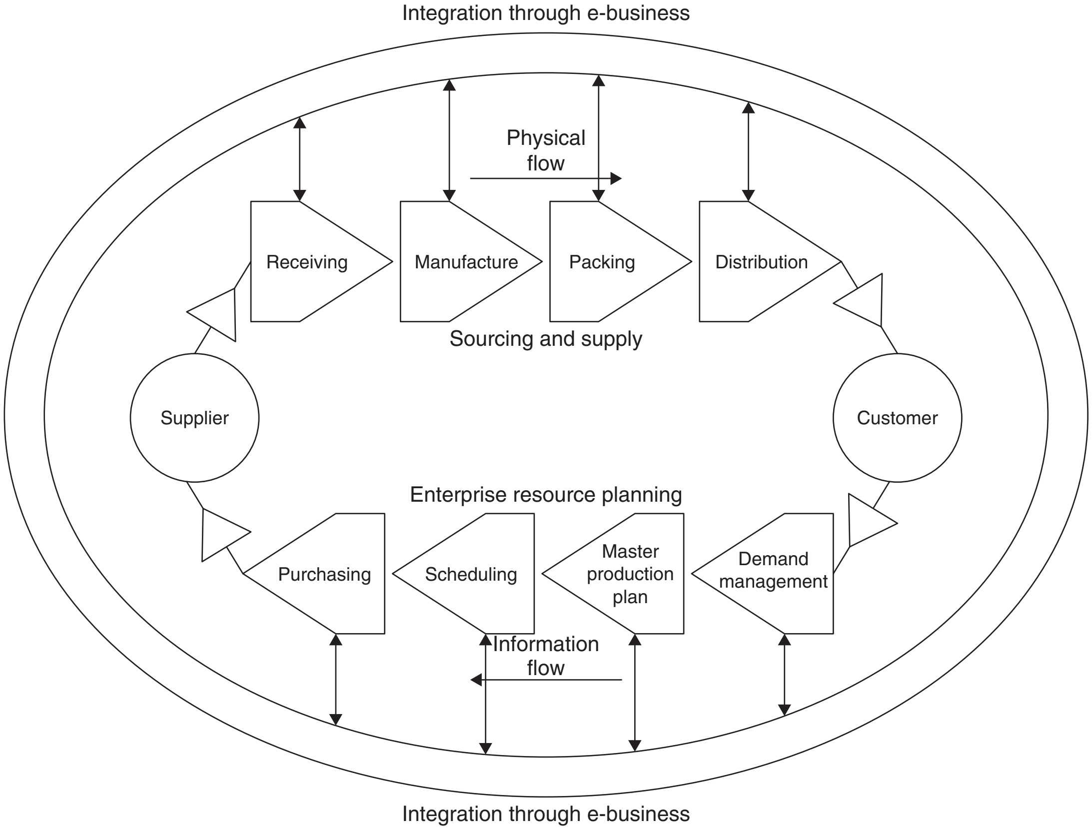

Figure 1.4 e-Supply chain or e-web.

How do you balance the voice of customer and voice of business in supply chain management?

In any business or operation, a manager has to find a balance between two conflicting objectives of demand from customer and supply from operations. The voice of customer (VOC) is articulated as customer service. Customer service is the primary objective of supply chain management. However, customer service has to be sustainable and balanced with efficient use of resources. The secondary objective of supply chain management is to reduce costs and to make effective use of resources. For simplicity, three key parameters of customer service are considered. These are specification, cost (or price) and timing. The customer expects the goods or service to be delivered according to acceptable standards, to be of an affordable price and that they arrive on time. The relative importance of specification, cost and time could change depending on the market condition, competition and the desirability of demand. The second objective, to efficiently utilize resources to meet customer service requirements is the voice of business (VOB). Given infinite resources, any system can provide adequate customer service, but many companies have gone out of business in spite of possessing satisfied customers (Wild, 2002; Wright and Race, 2004). To provide a sustained and sustainable level of customer service efficient use of resource is essential. A starting point of balancing VOC and VOB is resource utilization and customer service (RU/CS) analysis which aims to determine gaps between what is desired and what is feasible (Wright and Race, 2004).

The RU/CS analysis is a simple tool to establish the relative importance of the key parameters of both RU/CS and to identify their conflicts.

Wild (2002) suggests the starting point of the RU/CS analysis with the operations objectives chart as shown in Table 1.1.

Table 1.1 Operations objective chart

	Resource utilization			Customer service		
	Machines	Materials	Labour	Specification	Cost	Time
Operation						

The relative importance of the key parameters for RU (i.e. machines, materials and labour) and CS (i.e. specification, cost and time) can be given a rating of 1, 2 or 3 (3 being the most important).

When we study the apparently conflicting objectives of RU and CS, we realize that they have one thing in common, that is cost and price. If we can reduce the cost of production of goods or services down by improved resource utilization then we are in a better position to reduce the price to the customer.

RU/CS analysis does not provide solutions to the conflicts but identifies broad areas for attention. It is also important to note that the relative priorities of RU and CS can vary within the same business depending on the product and

Consider a mail order company where customers are expecting good value for money and do not mind receiving goods from catalogues within a reasonable delivery time. The operations manager has focused on the utilization of own resources to minimize operational costs.

Figure 1.5 shows the ratings of objectives, the actual performance and highlights the misalignment. It is evident that further examination is required for timing and material.

	Machinery/Space	People	Materials
Utilization objectives	**3**	**3**	**1**
Actual utilization	**3**	**3**	**2**
Alignment	✓	✓	✗

1 = low, 2 = medium, 3 = high

	Specification	Cost	Timing
Customer service objectives	**1**	**3**	**2**
Actual level of service	**2**	**3**	**1**
Alignment	✗	✓	✗

		Specification	Cost	Timing
✓	Good	✗	✓	✗
✗	Issues to look at			

Figure 1.5 The balance of objectives: Mail order company.

As shown in Figure 1.6, there is a conflict between cost and materials and further attention or a change of policy is required to resolve this conflict.

3 High relative importance	Machinery/Space	People	Materials
	3	**3**	**1**

1 Low relative importance	Specification	Cost	Timing
	1	**3**	**2**

	Machinery/Space	People	Materials
Specification			
Cost			✗
Timing			

Figure 1.6 RU/CS conflicts: Mail order company.

customer. To find solutions the supply chain manager will seek other tools, techniques and processes of supply chain management which we shall explain in later chapters. One such process is enterprise resources planning (ERP).

What is ERP?

The business objective is to convert customer demand by optimizing the utilization of resources to deliver effective customer service applies to all organizations regardless of whether they are in manufacturing or service sectors. ERP systems provide a single up-to-date database incorporating manufacturing, finance and human resource applications extended to include tracking of orders and inwards goods, work in progress and delivery of finished goods. The system is accessible to all departments for planning and execution of supply chain activities. Thus, ERP systems integrate (or attempt to integrate) all data and processes of an organization into a single unified system to achieve integration.

The term ERP originally implied systems designed to plan the utilization of enterprise-wide resources. Although the acronym ERP originated in the manufacturing environment as a successor to MRPII (manufacturing resources planning) today's use of the term ERP systems has much broader scope. ERP systems typically attempt to cover all basic functions of an organization, regardless of the organization's business or charter. Businesses, not- for-profit organizations, governments and other large entities utilize ERP systems.

How do you deliver value in supply chain management?

The delivery of goods and services of expected standards on time at the 'best in class' cost is creating value for money for customers and thus adding value to the business. An effective supply chain management team can deliver value by a value stream approach or total supply chain management approach.

The value stream approach transcends the traditional manner of departmentalizing stages of the business process. The value stream highlights the importance of the operations manager being involved in all aspects of the process, from suppliers right through to the customer and if possible to the customer's customer. The 'old' approach was that one department or function would be responsible for purchasing goods and services, another for planning. Scheduling of activities was often a separate function, as was warehousing and distribution, and operations were just one step in the whole process of providing services. With the value stream approach functional boundaries are ignored, and in many organizations, it is now accepted that the operations manager has to control the total process from purchasing input goods and services to the final stage of satisfying the customer. Marketing, accounting, human resources and

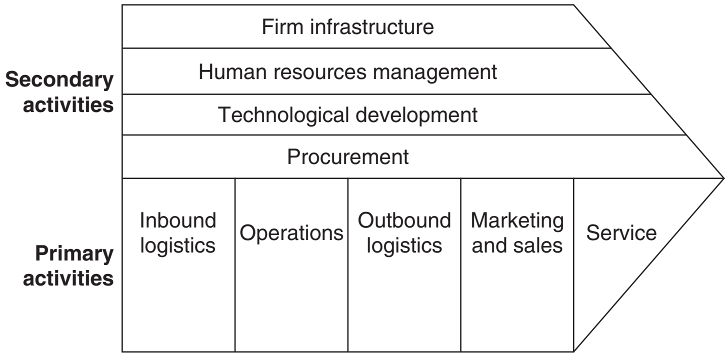

Figure 1.7 Porter's value chain.

other support functions do not show up on the value stream as such but operations managers must be vitally interested and involved in these internal functions of the organization.

The value stream approach in supply chain aligns well with Porter's value chain as shown in Figure 1.7. The idea of the value chain is based on the process view of organizations, the idea of seeing a manufacturing (or service) organization as a system, made up of subsystems each with inputs, transformation processes and outputs. How value chain activities are carried out determines costs and affects profits.

Most organizations engage in hundreds, even thousands, of activities in the process of converting inputs to outputs. These activities can be classified generally as either primary or support activities that all businesses must undertake in some form.

According to Porter (1985), the primary activities are:

1. *Inbound Logistics* involve relationships with suppliers and include all the activities required to receive, store and disseminate inputs.
2. *Operations* are all the activities required to transform inputs into outputs (products and services).
3. *Outbound Logistics* include all the activities required to collect, store, and distribute the output.
4. *Marketing and Sales* activities inform buyers about products and services, induce buyers to purchase them and facilitate their purchase.
5. *Service* includes all the activities required to keep the product or service working effectively for the buyer after it is sold and delivered.

Secondary activities are:

1. *Procurement* is the acquisition of inputs, or resources, for the firm.
2. *Human resource management* consists of all activities involved in recruiting, hiring, training, developing, compensating and (if necessary) dismissing or laying off personnel.

3. *Technological development* pertains to the equipment, hardware, software, procedures and technical knowledge brought to bear in the firm's transformation of inputs into outputs.
4. *Infrastructure* serves the company's needs and ties its various parts together, it consists of functions or departments such as accounting, legal, finance, planning, public affairs, government relations, quality assurance and general management.

The success of a supply chain could be synonymous to the success of the value stream approach or the total supply chain approach underpinned by the interaction between three key group of players, viz. customers, external suppliers and the departments involved with the primary and secondary activities of the organization.

The customer is the central focus for any organization. Churchill once said that war its too important to be left to the generals, and the same can be said of marketing. Marketing is too important to be left to the marketing department. Everyone in an organization should be vitally interested in marketing the organization. Nonetheless it is the function of the marketing department to *know* what the customer wants and what the competition is doing or is likely to do. Marketing specify the product and its attributes. Attributes may range from the essential down to the desirable and perhaps include extras that the customer does not even want. As well as defining the product or service to be offered, marketing has to establish the price, forecast demand, have a say in how the product or service will be distributed or delivered, and finally marketing is responsible for promotion with the aim of stimulating demand. Marketing also has to sell the product/service internally within the organization to the operations and other functions of the organization. Marketing is the link with the market and customers and operations.

In some organizations suppliers are treated with distrust, and the business strategy adopted is to shop around and to get the best deal on each occasion. In these types of organizations information is not shared with suppliers. When orders are placed the supplier is not told what the purpose of the order is, and thus are not in a position to advise, even if they were so inclined, of alternative products or new technology. With this approach little loyalty is shown to any supplier, and the supplier is almost treated as an adversary. The value stream approach is to treat key suppliers of goods and services as part of the team, and to share information and to seek advice. Key suppliers are those that are important to the smooth operation of the system. In some cases, the supplier can become involved in the day-to-day operations of the organization and might also be expected to advise and to assist in product development. Cost no longer becomes the key issue. Instead of price alone, suppliers will be judged on their loyalty and ability to deliver goods and services to the required standard and on time. Suppliers can also become part of the information-gathering arm of the organization; often suppliers have a different perspective as to what the competition are up to (changes in buying patterns, timetables, new packaging, use of new materials and so on). Suppliers are also in a good position to offer technical advice regarding new technology and alternative materials.

Communication between departments (especially marketing, operations and logistics) within an organization has to be two-way and has to be aimed to help rather than as a means of apportioning blame or criticizing. With traditional hierarchical organizations a bunker mentality can develop whereby each function is walled off from the other, and any suggestion, no matter how helpful, is taken as a threat or a challenge. World-class organizations are noted by the manner in which the figurative brick walls that separate functions have been broken down, and by the teamwork that exists between all functions to achieve the common goal. This requires that everyone in the organization knows what the goals and objectives are and that the culture is conducive to the enthusiastic pursuit of the goals for the common good of the whole, rather than for the specific interests of one department. Information is open to all and there are no secrets.

Summary

The primary purpose of this introductory chapter was to provide an overview of supply chain management principles and to indicate how an effective supply chain management process adds value to all types of businesses, whether in manufacturing or service sectors, public and not-for-profit organizations. It also aims to initiate the understanding of some core concepts of the book including ‘it is people, not processes or technology, that makes things happen’. It is critical to have data sharing and interaction between all stakeholders in the total supply chain using a value stream ‘total supply chain’ approach.

2

Why total supply chain management?

Introduction

In the 1960s and 1970s the manufacturing and supply strategy of multinational companies focused on vertical integration. One of the earliest, largest and most famous examples of vertical integration was the Carnegie Steel company. In the 1890s the company expanded to have a controlling interest beyond the mills where the steel was manufactured to include the mines from where the iron ore was extracted, the coal mines that supplied the coal, the barges and ships that transported the iron ore, the railroads that transported the coal to the factory, the coke ovens where the coal was coked, etc. One hundred years on vertical integration was still in vogue, for example in the 1980s Unilever, originally a soap manufacturer, had grown to own businesses and investments in forests, timber milling and refining, paper manufacture, board and plastics manufacture, chemicals, fast-moving consumer products manufacture and packaging, marketing and advertising, computer services, distribution warehouses, shipping and retail outlets. Vertical integration of a supply chain was not always successful. The New Zealand company, Feltex in the 1980s expanded from making carpet and furniture into owning a national retail chain. The next step in vertical integration was to buy a timber mill and a forest. At the time the carpet Feltex produced was world famous and exported all round the world. Expansion downstream in the supply chain to owning the retail stores, due to lack of retail experience and management, did not improve profits but resulted in a financial drain on the company. Expansion upstream to own the supply of timber (mill and forest) for the furniture factory proved to be a disaster. The forest was in remote rugged country and road access was poor. The cost of logging and transportation to the mill proved to be prohibitive. As a result of falling profits and share prices the company, once the largest manufacturer and exporter of manufactured goods in New Zealand and the darling of the share market, went through a series of ownership changes and downsizing back to the stage where it was only manufacturing carpet. Feltex finally went into receivership in September 2006.

In the 1980s (and subsequently) large organizations started to concentrate on their 'core business' and rather than to vertical integrate began divesting non-core arms of the business. The gradual privatization of the public sector also helped to create many supporting service industries. In the beginning of the twenty first century we are witnessing the explosion of outsourcing and the emergence of competent but lower cost manufacture in Eastern Europe, China and other states in South East Asia, India and South America (in particular Brazil). It is now recognized that in the global marketplace that a whole systems supply/value chain approach has to be taken embracing service and manufacturing as a whole. This chapter describes a total supply chain management concept and the analysis of the supply chain process. Management of the activities making up a supply chain are described in later chapters.

Trend towards service

In the UK statistics show that 78 per cent of the work force are engaged in service industries (www.statistics.gov.uk), and in the USA 80 per cent are employed in service industries (www.census/gov/). Although a shift back to manufacturing has been identified (Basu and Wright, 1997), it is obvious that the greater percentage of the work force of developed nations will continue to be employed in service activities. There are two reasons for this:

1. Continual advances in technology mean that manufacturing is considerably less labour intensive than previously. Automation, robotics, advanced information technology (IT), new materials and improved work methods all have led to the reduction of manual labour.
2. For larger organizations, manufacturing has become internationalized. For example, a company (such as Nike) might outsource its manufacturing to overseas contractors or allied companies and itself concentrate on design, marketing and distribution.

Additionally, organizations can no longer regard themselves as being purely in manufacturing and hope to survive. The market first and foremost now takes for granted reliability of product and expects good service.

Market expectations of the level of quality are driven by perceptions of what technology is promising and by perceptions of what the competition is offering. Organizations now operate in a global market where national barriers, tariffs and customs duties no longer provide protection for a home market. Any manufacturer, even if the focus has been on supplying a local market, is in reality competing on the world stage. Competition is no longer limited to other local organizations, and the fiercest competition in the home market will be from goods and even services produced overseas or provided by overseas organizations. For example, a bus service in New Zealand is owned and operated by the Scottish company 'Stagecoach' based 20,000 kilometres away.

And McDonald's for over 30 years have competed, and indeed set the benchmark, for fast food providers all around the world.

This overseas involvement in a home market means that manufacturers (and service providers) can no longer make products just to suit their engineering strengths, but must now be aware of what the market wants and what global competition is offering. In manufacturing what the competition is offering, apart from well-engineered products, is service in the form of delivery on time, marketing advice, training, installation, project management, or whatever else is required to provide a total service as well as a reliable product.

Never before has the customer been better travelled, more informed and had higher expectations. Many of these expectations began with the quality movement of the 1980s where it was trumpeted that the customer was king, and these expectations have been kept alive by continuously improved products and services, global advertising and for the last decade the World Wide Web.

If they are honest with themselves most organizations realize that their products actually differ very little from those of their competitors, and any technological improvement is soon copied; thus the difference – the 'competitive edge' – comes from service.

Service separated from production operations

If no serious operation can ignore market demands for service and world class quality, why bother to try and separate manufacturing from service in the study of supply chain management? Indeed for a manufacturing organization aspiring to world class status we would most emphatically agree that management of such organizations must concern themselves with service and quality if they are to compete on the world stage.

But managers in service industries such as health, retail, distribution, education, travel, real estate, consultation, brokering, law, accounting, administration of central and local government, transportation of goods or people – where no direct manufacturing is involved or where the manufacturing is light and simple (such as in a restaurant) – do not have to know much about manufacturing. Naturally all the above industries are reliant on manufacturers to varying degrees for the equipment they use, or in the case of a retailer for the goods they sell, but the physical heavy work of making the goods is not their concern. The analogy is that of a driver of a car: one can be a very good driver without knowing much about what happens under the bonnet. In some cars a knowledge of when to change gears, and understanding the danger of overheating due to lack of oil or water will be of advantage, but in other models the car will even 'tell' the driver when tyre pressures are low, turn the headlights on and off depending on light conditions and the driver need not worry about gear changing. Likewise, a retail sales person of washing machines does not need a detailed knowledge of high-tech mass production line balancing. For the sales person some knowledge of lead times for deliveries, operating instructions and the capacity of the washing machine will be sufficient as a basis for good service to the customer.

Thus, there can be a separation of operations management into two broad streams: the management of production including service, and the management of operations in service industries where only some rudimentary knowledge (if any) of manufacturing is required. But irrespective of whether a manager is involved primarily in production or service, a total system approach is needed based on the supply or value chain philosophy.

For organizations involved directly in production and manufacturing, management needs to be well versed in strategies, tactics and methodologies of production operations management and also has to be very aware of what constitutes service and quality from the customer's point of view. A total operations approach to providing a quality product coupled with the service required is essential.

Managers of service industries will benefit from some basic knowledge of production systems and methodologies.

Shift from enterprise to network

A little more than a decade ago, companies were urged to attain 'world class' performance within the enterprise. The departments within a company were striving for islands of excellence and then with a succession of operational excellence initiatives (e.g. TQM, BPR, MRPII and Six Sigma) the fences between departmental turfs were gradually demolished. The organizations started to become customer focused and with established performance metrics in all areas of the business (e.g. 'Balanced Scorecard') began to emerge. However, it is fair to say that both the business model and the performance metrics were site-centric or at most were confined within the company or enterprise. Today with web-based technologies now accelerating the collaborative supply chain, it is becoming imperative to rethink the selection and implementation of the external metrics. This shift is not only in the measurement criteria, but also in the mind-set of business practices. Collaboration requires a capacity to work in association, sometimes, with the 'enemy' and does not achieve its business success at the competitor's expense. To maximize the advantages of collaboration, the buy-in and commitment of employees to the new mind-set is essential. The following are a few reasons for this fundamental shift from a site-centric linear supply chain to a collaborative network or web of supply:

1. *Demands for flexibility of partnerships*: In today's marketplace consumers have degree of choice and greater ability to make a comparison. As a result their expectations are rising and needs constantly changing. Value in this environment is a moving target. Organization must be flexible to be able to adapt to these changes. It is very difficult for a single organization to possess all the capabilities required to keep up. Organizations now look for suppliers who can provide the skills and capabilities needed as and when they require them. A firm can easily form partnerships with appropriate

skilled suppliers to last as long as the need exists. As demand changes so do partnership arrangements.

2. *Advances in technology*: The merging of information and communication technologies (ICT) has supported the growth in supply chain partnerships. These technologies have enabled extensive connectivity. Today's computer networks, open systems standards and the Internet enable people working in different areas of the supply chain to maintain constant contact. Since information transactions have become so easy, there is less of a need to restrict operations within traditional organizational boundaries. The new capabilities of e-supply chain offer the ability for supply chain partners to share information in real time. This enables the partnering firms to hold lower inventories and incur fewer transactions costs. These lower costs can in turn be passed on to the customer in the form of lower prices and better value, or alternatively retained as increased profit.
3. *Collaborative networks*: Companies have now recognized that great improvements in value can be attained by co-ordinating the efforts of partners along the supply chain. When firms focus only on their internal operations they are making decisions in isolation and as a result this can lead to the overall performance of the supply chain deterioration. As we will see later, firms who work together and share their plans and other information are actually able to improve the overall supply chain performance to their mutual benefit.
4. *Recognition of core competencies*: Recently, there has been a shift away from focusing on markets and products towards considering what the organizations capabilities are. A focus on core competencies allows a firm to concentrate on those few skills and areas of knowledge that make the organization distinct and competitive. These competencies are what provide the firm with its competitive advantage. Recognizing what processes they are best at allows the firm to concentrate on these processes. This has led to firms rationalizing what they do and the emergence of supply chains where each of the partnering organizations focuses on what individually they do best.
5. *Growth in outsourcing*: The dynamic growth in the large emerging economies, especially China and India, especially of manufacturing, supply and service capabilities has provided opportunities for new outsourcing partners. When a specific process moves from a competitive advantage to a commodity and/or when a supplier's operation performance is superior to organization's own performance, outsourcing must be considered. A well-documented example of business process outsourcing (MCA, 2002) is the Coca Cola Corporation. For over 100 years Coca Cola has been producing syrup but the actual production of Coca Cola is the responsibility of its global network of business partners. A recent study by IBM (IBM Global Services, 2006) demonstrates that companies engaged in IT outsourcing realize improved financial health and performance in comparison to their sector peers.

Increased complexity of processes

The processes in the supply chain are becoming more and more complex both in terms of variety of products and variability of operations. In a preferred condition, high volume and low variety of products and low variation in manufacturing processes will deliver products at a lower cost in comparison to a situation with low volume, high variety and high variation. Increase in customer contacts and choice has led to the need for complex supply chains with many variables.

The impact of this increased complexity is challenging the stability of supply chains. This challenge is compounded by the multiple stages and stakeholders in the supply chain from the demand point to the source of supply. The variability in demand increases as it moves along the supply chain away from the retail consumer. Small changes in consumer demand can result in large variations in orders placed upstream. This variation can oscillate further in larger swings as each stakeholder in the supply chain attempts to solve the problem from its own point of view. This phenomenon is often cited as 'the bullwhip effect' (see Figure 2.1) and has been experienced in most industries following linear supply chain principles resulting in increased cost to organizations and poorer service to customers. The bullwhip effect is discussed in greater detail in Chapter 14.

Figure 2.1 The bullwhip effect.

Case example: Collaborative forecasting

The case example involves three individual companies representing a brand owner (manufacturer), a first tier supplier and a second tier supplier. The target is to build a lean and transparent business model in a three-entity demand chain.

In the traditional process the purchase order is the key impulse for the supplier whereas in this model the key input is the rolling forecast. The challenges of the implementation come from forecasting capabilities, openness and trust. The utilization of modern ICT technology also creates both challenges and advantages.

A selected starting point for this example is that the collaborative forecasting model exists already between two parties and this model is extended one step further. In a two-entity chain the forecast of the customer affects the supplier. In this example, where the second tier supplier is included the initial forecast of the brand owner affects another step higher in the upstream. Furthermore, the planning process of the first tier supplier, where the manufacturer's forecast is processed into raw material forecast to the second tier supplier, plays a key role. A general description of the model is shown in Figure 2.2.

Figure 2.2 Collaborative forecasting model.

The production processes in all three parties involved are different – it varies from process industry to manufacturing. The process industry is capital intensive and the profitability depends more on capacity utilization. In manufacturing the production cycles are shorter and the working capital tied to the process has higher impact on the profitability. Hence, the key drivers for effective planning in each party are not the same.

As the collaborative forecasting between the manufacturer and the first tier supplier is already in place, the key metrics between them is treated as the best practice when defining the targets for the second tier supplier with the first tier supplier.

The new business model reduces the inventory levels and increases the inventory turnover in the second tier supplier/first tier supplier part of the demand chain. Other expected benefits are less out-of-stocksituation, less non-optimal transports, better planning and production efficiency at the second tier supplier and increased customer satisfaction.

In order to sustain these results, a thorough commitment based on trust is expected from each partner. In practice, it also means implementing new ICT tools to share data and monitor the supply chain.

Adapted from Lukka and Viskari (2004)

Supplier partnership

Reviewing the impact of new technologies on supply chain provides an interesting development of partnering with suppliers. In the past many manufacturers regarded their suppliers with some suspicion, almost as adversaries. Little loyalty was shown to the suppliers and consequently the supplier was never certain as to their future relationship with an organization. Often the purchasing or procurement department would see their role as screwing the best deal possible from a supplier. The huge growth in outsourcing and more importantly the online access to information by Internet have changed that. Companies have realized that achieving world class excellence in their own sites is not enough. It is important to raise the standards of suppliers as well as learn from them by working in partnership with them. The tightly controlled service level agreements are being replaced by joint service agreements with free exchange of data and knowledge. However, the success of the benefits will depend on mutual trust, a highly developed commercial relationship and an efficient system of data exchange. In order to improve the effectiveness of data exchange, companies are sharing with their suppliers (and customers) common systems such as EAN (European Article Numbering) standards, EDI (Electronic Data Interchange) and web-based Extranets. For example, EDI enables companies to communicate with each other. Purchase orders to suppliers can be eliminated by using customers' order schedules. And by EDI and Extranets, the supplier could be authorized to link directly into the manufacturer's MRPII (manufacturing resource planning) or ERP (enterprise resource planning) system. The emergence of the Internet protocol has helped the interaction between powerful supply chain systems such as i2, Manugistics, Ariba, Oracle and SAP/R3.

Total supply chain management?

Our above analysis of the key factors and new developments in supply chain management clearly indicates that focusing on the conventional practices of supply chain management within the organization, such as forecasting, capacity planning, inventory management, scheduling and distribution management, may achieve operational excellence within the confines of an individual business organization but will offer only a partial solution to optimizing customer service. It can be compared to sitting in a high-performance motorcar in a traffic jam, the sound system and air conditioning might be state of the art but the overall travel experience is not great. Likewise, what is the point of having a perfect stainless steel link in a rusty chain? Unless the whole process is efficient the individual unit cannot achieve its potential.

It is therefore vital for any organization, being more and more dependent on both local and global outside resources and information, to work in harmony with all stakeholders of the supply chain including customers and suppliers. We need a holistic value stream approach to supply chain or a total supply chain management approach.

In 'Total Manufacturing Solutions' (Basu and Wright, 1997), we defined total manufacturing to include all the interactions between the conversion process inside a 'factory' with all other business processes including marketing, research and development, supply chain management, financial and information management, and human resource management – also with external factors such as environmental concerns, customer care and competition. The method of analysis which in effect determined strengths, weaknesses and gaps in performance was developed around 200 questions designed for self-benchmarking against world class standards. The structure of the benchmarking was to measure the performance of the business against 20 defined areas of the business which were described as foundation stones. There were 10 questions for each foundation stone. The aim being to get the right balance of foundation stones to support the pillars of the business. Over a period of 8 years we refined the six pillars and the 20 foundation stones of Total Manufacturing Solutions to give a greater emphasis on service and relationships with suppliers, and customers. Partnering and alliances were also included in a new model which we named 'Total Operations Solutions'. In Total Operations Solutions (Basu and Wright, 2005), we continued to provide a process of self-assessment to systematically measure all aspects of an organization, be it manufacturing or service. This includes both internal functions and external relationships. We show how the concepts of Six Sigma as further developed in 'Quality Beyond Six Sigma' (Basu and Wright, 2003) can be used without too much fuss to determine strengths and weaknesses. Quality Beyond Six Sigma is written around 'Fit Sigma'. Fit Sigma was developed by Ron Basu to build on strengths and to understand where weaknesses are so that corrective action can be taken to gain a competitive advantage.

Building upon the experience of the holistic models for Total Manufacturing Solutions and Total Operations Solutions we have now developed a model for Total Supply Chain Management comprising six building blocks, viz.:

1. Customer focus and demand
2. Resources and capacity management
3. Procurement and supplier focus
4. Inventory management
5. Operations management
6. Distribution management

These building block are integrated by three cross-functional process, viz.:

1. Sales and operations planning
2. Systems and procedures
3. Performance management

The importance of total supply chain approach can be evaluated by value stream mapping (VSM) (Basu, 2004, p. 118). VSM is a visual illustration of all activities required to bring a product through the main flow, from raw material to the stage of reaching the customer. According to Womack and Jones (1998), the initial objective of creating a VSM is to identify every action required to make a specific product.

Case example: The value stream of a cola can

Consider a cardboard case containing eight cans of cola chosen at random in the beverages aisle at a Tesco store.

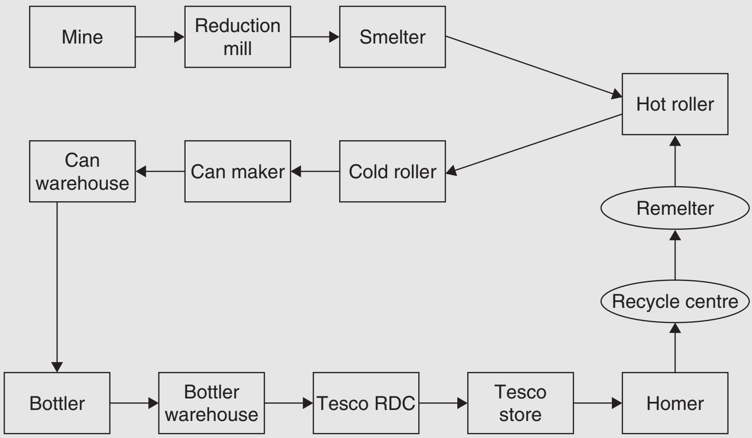

Figure 2.3 Value stream for cola cans.

Figure 2.3 shows a VSM of cola, from the mining of bauxite (the source of aluminium of the cans) to the user's home. Bauxite ore is mined in Australia and then transferred in trucks to a nearby chemical reduction mill to produce powdery alumina. Bulk alumina is then shipped by boat to Norway with cheap hydroelectric power for smelting. The molten aluminium is cast into ingots which are then shipped by trucks, boat and trucks to Germany. The ingot is heated to 500°C and then passed through successive rollers to reduce the thickness from 1 metre to 3 millimetres and stored as coils. The coils are then transferred by trucks to a cold rolling mill where the aluminium sheets are reduced from 3 millimetres to a thickness of 0.3 millimetre suitable for can making. The thin coils are then shipped to a can maker's warehouse in England. Cans are manufactured and then stored. From the can maker's warehouse cans are then transferred to the bottler's warehouse in pallets. They are then de-palletized and loaded into the can filling line where they are washed and filled with cola. At the end of the filling line cans are then unitized in stretch wrapper and stored in the warehouse on pallets. They are then transported on trucks to Tesco's Regional Distribution Centres around the UK and then distributed to Tesco's supermarkets. When cola is taken home it is typically stored again and chilled and finally consumed. Empty cans are then recycled to reintroduce it into the production process at the smelting stage.

Table 2.1 Quantitative data of cola cans

Cumulative	Incoming storage	Process time	Finished storage	Process rate	Days
Mine	0	20 minutes	2 weeks	1000 tons/hour	319
Reduction mill	2 weeks	30 minutes	2 weeks	–	305
Smelter	3 months	2 hours	2 weeks	–	277
Hot rolling mill	2 weeks	1 minute	4 weeks	10 feet/minute	173
Cold rolling mill	2 weeks	<1 minute	4 weeks	2100 feet/minute	131
Can maker	2 weeks	1 minute	4 weeks	2000/minute	89
Bottler	4 days	1 minute	5 weeks	1500 minutes	47
Tesco RDC	0	0	3 days	–	8
Tesco store	0	0	2 days	–	5
Home storage	3 days	5 minutes	–	–	3
Totals	5 months	3 hours	6 months	–	319

The quantitative data related to the activities in the value stream are summarized in Table 2.1.

It is evident from the details in Table 2.1 that value added activities take only 3 hours compared to the total time (319 days) from the mine to the recycling bin. This proportion is surprisingly small when one considers the alarmingly lengthy overall duration of the process.

Adapted from Womack and Jones (1998, pp. 38–43).

We believe that the above example of the value stream for a carton of cola firmly establishes the need for a total supply chain management approach. It is important to note that most of the 40,000 other items in a typical supermarket would produce similar results. The impact of the value stream or total supply chain approach in the service sector is not so dramatic as fast-moving consumer goods (FMCGs), but highly significant all the same.

Summary

The key issues of supply chain as discussed in this chapter emphasizes a need for a total supply chain management approach. With the expansion of outsourcing and Internet driven e-supply chain, it is essential that key players and stakeholders understand the importance of the accuracy and transparency of data for collaborative management for mutual benefits. Improved forecast accuracy and the real-time exchange of data not only reduces the 'bullwhip effect', but also reduces processing cost, inventory level and improves customer service. We have also discussed the trend towards the service-based economy and the importance of total supply chain management in the service sector. The building blocks of the supply chain underpinned by the total supply chain management approach as explained further in this book will assist in the improved understanding and management of a collaborative supply chain.

3

Understanding total supply chain management and its building blocks

Introduction

In Chapter 2, we discussed the need for a total supply chain management approach and introduced the concepts of building blocks. The importance of each building block is explained in this chapter. No block stands alone, each is a component of the whole. In combination the blocks show activities, stages and processes of the extended supply chain. The sequence of processes creates a flow between different stages to fulfil a customer's need for a product or a service. The processes of making things happen within a supply chain can be viewed as a sequence of progressive cycles (e.g. planning cycle) or the nature of response to a customer order (e.g. push or pull). There are debates between supporters of make to order policy and make to forecast policy as if one policy is better than the other regardless of customers, demand patterns, products or organizations. Therefore, we aim to explain in this chapter:

- What are the process views of a supply chain?
- What are the building blocks of a supply chain?
- Are all the building blocks suited to all organizations?

What are the process views of a supply chain?

Chopra and Meindl (2003) describe the two views, viz.:

1. *Cycle view*: The processes in a supply chain consist of a series of cycles, each performed at the interface between two successive stages.
2. *Push/pull view*: Pull processes are initiated by a customer order and push processes are initiated and performed on the forecast of customer orders.

Cycle view

The cycle view of a supply chain consists of several stages of process cycles and form the components of MRPII (manufacturing resource planning) or ERP (enterprise resource planning) systems and are shown in a simplified form as three process cycles as shown in Figure 3.1 These cycles are discussed in more detail in Part 2 (Chapters 4–9).

Figure 3.1 Simplified process cycles in supply chain.

The demand cycle is the cycle of time covering from when a customer buys or orders from a retailer or wholesaler. The demand cycle can also be based on the forecast of demand. If the retailer holds the product in stock then the demand cycle will comprise of order request, order fulfilment and order receiving. However, if the product is not readily available then the customer order request will form a part of demand forecast which also includes predicted demand, market intelligence and promotion of the product.

The planning and procurement cycle covers short- and longer-term requirements. The demand of the product and its components (bill of materials) are compared with the inventory and capacity and the replenishment requirements are planned. Planners will decide what to buy and what to make. This make or buy decision process also applies to a service organization leading to either in-house or outsourced services.

The supply cycle typically occurs with a production schedule if the product is to be manufactured, or a purchase schedule if the product is to be procured from an external supplier. Once finished goods are manufactured or received the next stage of the supply cycle is direct delivery to customers or storage in the warehouse and subsequent distribution to customers.

Push/pull view

A push process conforms to a conventional supply chain management system going through typical stages in sequence. As shown in Figure 3.2, orders arrive at or after the demand cycle but always before the planning and procurement cycle and process is activated by a forecast or demand plan. Both raw and packaging materials are stored before production and products are manufactured to stock. The order fulfilment is achieved from the inventory of finished products.

A pull process is activated in response to a confirmed order from a customer. This includes make to order or a just-in-time (JIT) manufacturing process. As shown in Figure 3.3, in a pull process the supplier does not stock finished products but holds higher quantity of semi-finished materials and often higher supply

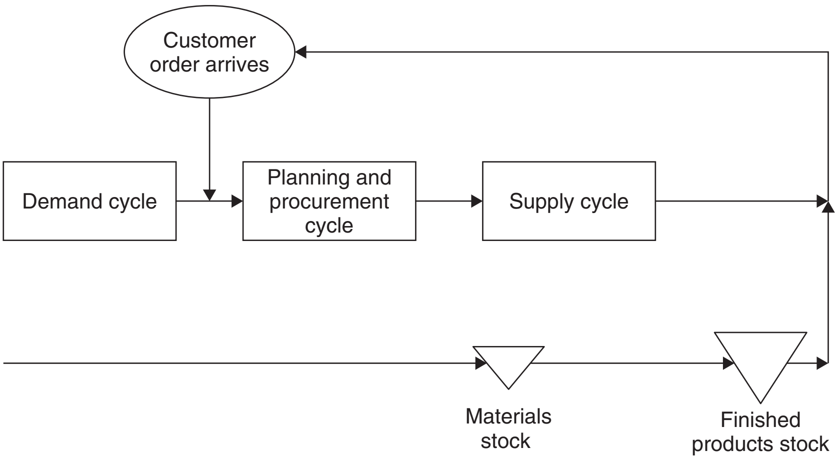

Figure 3.2 Push process in supply chain.

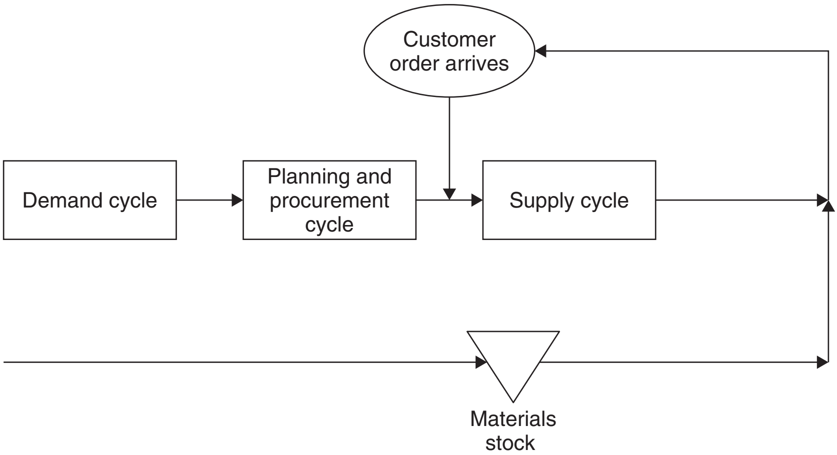

Figure 3.3 Pull process in supply chain.

capacity so that order fulfilment can be achieved rapidly. The orders arrive at or after the planning cycle as if bypassing a few steps of the traditional ERP process.

A pull process is also associated with Kanban[1] and Lean Thinking or Lean Manufacturing which are covered in more detail in Chapter 13. In essence, lean manufacturing requires materials to arrive into each stage of production just

[1] Kanban literally means ‘card’. Originally developed by Toyota in the 1980s, a Kanban was usually a printed card in a transparent plastic cover that contained details of specific information such as part number and quantity. It is a means of pulling parts and products through the manufacturing or logistics sequence as needed ‘just-in-time’. Most Kanban systems are now computerized. Kanban is fully explained in Chapter 13.

when required and no buffer stocks of inwards or outwards stocks of materials are held. The lean approach is also referred to as JIT. Pull processes control the flow of resources in the production process by replacing only what has been consumed. Production schedules are based on actual demand and consumption rather than forecasts. With lean manufacturing there is no room for errors in specification, production or late delivery.

Case example: A pull system implementation

A heating and ventilation company in Canada employs 250 people and supplies products to new homes and for property renovation. The declining Canadian dollar was increasing costs and competition was getting tougher. Customers were more demanding and margins were eroding.

Customer requirements were met by scheduling production based on a forecast using an MRP (materials requirement planning) system. Although the finished goods warehouse was full and storage was becoming a problem, on time deliveries to customers were under 80 per cent. Lead time was 3 weeks from quote to shipment to customer. Part of the warehouse was set aside for returned goods (for when a unit or units were returned because they did not meet customer specification).

Led by their manufacturing team the company started an improvement strategy based on Lean principles and shared it with all the employees including administration office staff. All employees were then trained in the principles of Lean and they started to change by thinking about the improvement strategy. The key initiative was to convert from a scheduling system based on sales forecast to a 'pull system' (Kanban) based on customer demand.

The results were remarkable. For example:

- Lead time reduced from 3 weeks to 2 days.
- On time delivery was increased to 96.5 per cent.
- Stocks of finished goods were reduced by 60 per cent.
- The return area was converted into R&D where new products were developed to fill the released warehouse capacity.
- Daily production meetings were reduced from 1.5 hours to half an hour.
- Employees were more involved and empowered.

Despite the dollar continuing to decline and customers becoming more demanding, margins started to improve.

What are the building blocks of a supply chain?

From the pull system used in the Canadian company one might be tempted to believe that forecasting and making to stock is inefficient and old fashioned.

Further, in the well documented model of Dell Direct (see Basu and Wright, 2005, pp. 334–337), where the traditional retail channels are bypassed through the manufacturer selling and delivering direct to customer, it might be considered that wholesalers, distributors and retailers are redundant. These are good examples but are isolated approaches to suit particular circumstances and products. For example, some products are best processed in batches and stocked in bulk (e.g. food processing and cool stores). In the course of this book we aim to establish the appropriateness of each model in the context of a big picture approach.

It is therefore important that a 'total supply chain management approach' is applied and all the building blocks of the supply chain are examined. The synergy that results from the benefits contributed by all elements as a whole far exceeds the aggregate of benefits achieved for an individual elements. The integrated approach is truly more than the sum of its elements. If one concentrates exclusively on isolated areas, a false impression may be inevitable and inappropriate action taken.

This maxim can be illustrated by the Indian folk tale of four blind men who were confronted with a new phenomenon, an elephant! The first man, by touching its ear, thought that the elephant was a fan. The second was hit by the elephant's tail and concluded that it was a whip. The third man bumped into a leg and thought it was a column, while the fourth on holding the trunk decided that it was an over-sized hose. Each man, on the evidence he had, came to a logical conclusion, but all had made an erroneous judgement by failing to deduce that the total object was an elephant. As with all feedback devices where a basic message is given, inferences and decisions may be drawn from isolated data which will be false and misleading.

A story in the business context will further underline the limitation of tackling only a part of a total problem. The technical director of a multinational company, having been to a conference, decided that line performance improvement must be the best thing in manufacturing. So he organized his technical team, called in experts from the corporate headquarters, and set up a line efficiency exercise. The team did an excellent job on two production lines by systematically eliminating all machine-related downtime problems (with the aid of video recording analysis). As a result the production efficiency of the lines increased by 20 per cent. However, it soon transpired that the product for one of the lines was going to be discontinued and the other line, despite its excellent standard of reliability and efficiency, encountered a severe long-term shortage of materials due to planning and procurement problems. Therefore, in isolation the line efficiency programmes did not improve the overall business performance.

As we mentioned in Chapter 2 our model for total supply chain management comprises six building block configurations, viz.:

1. Customer focus and demand
2. Resource and capacity management
3. Procurement and supplier focus
4. Inventory management

5. Operations management
6. Distribution management

And three cross-functional integrating processes, viz.:

1. Systems and procedures
2. Sales and operations planning
3. Performance management

This model is illustrated in Figure 3.4. The composition of building blocks by supply chain configuration and supply chain integration is shown in Figure 3.5. Each of the supply chain configurations will be covered in more detail in Part 2 and the integrating processes in Part 4.

Customer focus and demand

Customers are both at the start and the end of the supply chain. A customer is the one who is paying for the goods or services or is most affected by the outcome of the process. In a supply chain a customer could be a consumer, wholesaler, distributor or retailer. The demand for a product or service is created by customers.

The basis of all supply chain planning and decisions is underpinned by the forecast of future demand. A supply chain process cannot exist without the knowledge and planning for future. All push processes are executed in anticipation of customer demand and all pull processes are carried out in response to customer demand. It is a misconception that demand forecast is not required in a pull or JIT process. Without a forecast of future demand in a pull system a manager cannot plan the capacity and have the resources required to respond to a customer order. For a traditional push process a manager plans the level of production and capacity based on the forecast of future demand. Even in a service industry, where the demand is not discrete, business planning will be unsatisfactory without an estimate of future demand. In a not-for-profit organization demand is unpredictable but it has customers and it has a core budget based on demand forecast.

In all instances of a supply chain the first step is to forecast what the customer demand will be in the future. It is important to note that is not possible to produce a perfect forecast as there are so many variables affecting a future demand, such as past demand, promotion and advertising of the product, market share, state of the economy, price discounts, competition and new products introduction. Peter Drucker once said 'the best way to predict future is to create it'. There are also some recognized characteristics of forecasts, for example, there will always be a forecast error, longer-term forecasts are less accurate than short-term forecasts and aggregate forecasts are usually more accurate than individual forecasts.

This building block of customer focus and demand including forecasting methods is covered in more detail in Chapter 4.

Resource and capacity management

A primary objective of supply chain management is to optimize supply capacity to fulfil demand in time. In the real-world resources are not infinite. Satisfying customers on time can be crucial. An increase in capacity, be it machines and equipment, warehouse space, transport, stocks of input materials and finished product, and of course people, is expensive. Therefore, a supply chain manager must make decisions regarding capacity levels and buffer it to meet the variation in demand either by adjusting capacity or producing to hold output stocks of goods. An organization may provide excess capacity to satisfy demands for peak period or set an upper limit of the capacity based on the average demand and balance the cost of holding excess inventory on one hand or losing sales on the other.

There are a few options of capacity optimization open to a manager and there are proven processes to assist him or her. One such process is aggregate planning where an organization determines levels of capacity, production and inventory over a planning horizon to maximize the profit. The optimization can be attempted either in theory by a mathematical model (e.g. linear programming) or in practice by a cross-functional continuous review process (e.g. sales and operational planning, S&OP). Our preferred and practical option is S&OP which is covered in Chapter 18.

Another proven process is ERP which has evolved from MRP and MRPII. ERP is closely linked with S&OP and comprises a series of sequential processes by using a single set of databases, viz. demand planning, rough-cut capacity planning, master operations scheduling, MRP, detail capacity planning, purchase scheduling and production scheduling. Number crunching is done using a computer system such as SAP R/3. The success of ERP depends on the structured review process by planners, managers and users.

This building block of resource and capacity management including ERP is covered in more detail in Chapter 5.

Procurement and supplier focus

The optimization of internal capacity can be supplemented by buying in external capacity and resources. As Reid and Sanders (2002, p. 56) say 'make or buy is a type of backward integration decision, where the company decides whether to purchase certain materials or tasks or perform the operation itself. Often this is called outsourcing. Many companies routinely out-source certain services, such as janitorial services, repair, security, payroll, or records management'. For the supply chain procurement of external capacity and resource could include packaging materials, part built-up assemblies, contracting out utilities and maintenance, hiring contract or casual labour, selecting approved suppliers and outsourcing. An example of part built-up assemblies is where an American car typically consists of 25,000 components to be assembled on the manufacturing line, a Japanese car of a similar class might only consist of 12,000.

In a typical manufacturing organization the cost of bought in resources accounts for 60–90 percent of the cost of goods sold (COGS). Thus, a powerful way to improve shareholder returns is to address reduction of purchasing costs. A proper purchasing and supply management can give a network of suppliers capable of delivering service quality beating competitors at the same time securing cost reduction over time. In a market driven competitive world, businesses are continuously seeking new suppliers and partners, including outsourcing.

The Internet has provided new challenges and potential solutions and has enabled extensive connectivity. As Wright and Race (2004, p. 210) say ‘today’s computer networks, open systems standards and the Internet enable people to working in different areas of the supply chain to maintain constant contact. Since information transactions have become so easy, there is less of a need to restrict operations within the traditional organizational boundaries. These new capabilities offer the ability for supply chain partners to share information in real time. This enables the partnering firms to hold lower inventories and incur fewer transaction costs. These lower costs can be passed onto the customer in the form of lower prices and better value. Or, alternatively retained as increased profits. Companies have now recognized that great improvements in value can be attained by co-ordinating the efforts along the supply chain. When firms focus only on their internal operations they are making decisions in isolation and as a result this can lead to the overall performance of the supply chain deteriorating’. In short firms that collaborate, share plans and information are able to improve the overall supply chain performance to their mutual benefit.

The development of a professional service industry has also in recent years increased considerably; however, as observed by Mitchell (1998) purchasing teams appear to have made less effort to reduce costs by outsourcing services. Nonetheless the importance of service level agreements and supplier partnerships are growing in the global supply chain. A survey by Wade (2003) showed that 31 per cent of total procurement cost is for bought in services.

The selection of appropriate or preferred suppliers should involve alternative and complementary attributes between the suppliers and the receiving organization. Slack et al. (2006) suggest four basic capabilities to make sensible trade-offs, viz.:

1. *Technical capability*: The product or service knowledge to deliver sustainable quality.
2. *Operations capability*: The process knowledge to ensure effective supply.
3. *Financial capability*: The financial strength to fund the business.
4. *Managerial capability*: The management talent to develop future business.

It is important to raise the standards of suppliers as well as learn from them by working in partnership with them. Tightly controlled service level agreements are being replaced by joint service agreements with free exchange of data and knowledge. Success will depend on mutual trust, a highly developed commercial relationship and an efficient system of data exchange.

This building block of procurement and supplier focus including outsourcing is covered in more detail in Chapter 6.

Inventory management

The purpose of inventories or stocks is to buffer against the variations in demand and supply. Inventories usually reside in three stages of a process, viz. input stocks (e.g. raw and packaging materials), in process stocks (e.g. semi-finished products) and output stocks (e.g. finished products). Wild (2002) introduced the concept of consumed and non-consumed stocks. Consumed items (e.g. materials or products) are used by the process or customers and must be replenished in shorter cycles. Non-consumed items (e.g. capital equipment and labour) are repeatedly used by the process needing repair and maintenance and are replaced in longer intervals.

Inventories could be allocated either by design or can accumulate as a result of poor planning and scheduling. Generally, inventory is viewed as a negative impact on business incurring costs of capital (interest paid or interest foregone), storage space, handling, insurance, increased risk of damage and theft, and obsolescence. On the other hand, lack of inventory leads to lost production in the factory and lost sales at the end of the supply chain. Holding inventory of materials and finished products can be seen as an insurance against uncertainty of supply and to overcome unforeseen variations in demand.

Inventory management is a good indicator of the effectiveness of supply chain management. It is relatively easy to achieve higher levels of customer service by accumulating excessive stocks. It will also obscure short-term operational problems. But this is a costly and risky option in terms of cash flow. Obsolete inventory, be it for changes in technology, fashion or in foodstuffs past the use by date has little salvage value. It is vital to optimize the inventory level.

In optimizing inventory levels two types of stocks are considered: cycle stock and safety stock. Cycle stock depends on costs associated with ordering, transportation, quantity discount, lead times from suppliers and customer demand. Safety stock is the buffer against the variation of demand during the lead time and depends on forecast accuracy, reliability of suppliers and customer service level.

In service industries operations managers might have a nonchalant attitude towards inventories but not so the accountants. Differences between services and physical goods are addressed both from operations and marketing. Among the differences identified within marketing and operations literature are intangibility, heterogeneity, inseparability and perishability (Grönroos, 2000). It is perceived that services are one-off and cannot be stored. There are of course consumed stocks (e.g. stationery) in service industries for conventional inventory management. However, in the service sector more emphasis should be focused on managing non-consumed stock (viz. database and skilled people).

This building block of inventory management is covered in more detail in Chapter 7.

Operations management

In a supply chain operations management is the building block that makes things happen. This is where plans are executed in factories and facilities to produce goods or services for customers. Operations management is the activity of managing resources and processes that produce goods and services. Input resources (viz. information, materials and utilities) are transformed by three converting components (viz. people, process and technology) into desired outputs. Along with distribution management, operations management accounts for the physical flow of the supply chain. Most texts on operations management give scant coverage of supply chain management.

Operations exist in all types of supply chain whether it is for delivering a product or a service. A popular perception of an operation is where physical activities or transformations are involved (e.g. manufacturing). If you think, that you do not have an operation if you are in sales and marketing, or banking or insurance, or health service or charity organizations, you are incorrect. You will always have an operation as long as you use resources to produces products, services or a mixture of both. In other words if you have input, process and output you have an operation. During 1960s and earlier operations management was exclusively the domain of manufacturing industries. Since 1970s operations management is used in both manufacturing and service sectors, and it also implies a service operation can be decoupled as repetitive and non-repetitive operations and manufacturing principles and techniques can be applied to repetitive service operations. More recently the term operations and process management has been used to cover all parts of the organization. In this book, operations management will include all types or parts of organizations.

This building block of operations management will be covered in more detail in Chapter 8.

Distribution management

There is no doubt that supply chain order fulfilment is the Achilles heel of the e-business economy. At the end of every e-commerce, on-line trading and virtual supply chain there is a factory, a warehouse and a transport. Internet has elevated the performance of information accessibility, currency transactions and data accuracy, but the real effectiveness of supply chain from the source to customer cannot be achieved without the physical efficiency of the supply chain. Web-based software and e-market places are increasing the alternatives available to e-supply chain managers in all operations including the service industry. More opportunities may also mean more options and complexity. Therefore, it is vital that a process is in place to ensure the performance of e-supply chain for both virtual and physical activities.

Many organizations outsource distribution activities to third parties and do not employ in-house expertise to manage distribution which directly affects the customer service. If there is a failure in order fulfilment whether it is due to quality, quantity or time or even the attitude of distributor then the organization, not the distributor, bears the consequence. The problems or returned goods or reverse logistics are becoming a growing concern in supply chain management.

This building block distribution management addresses this challenge under two headings:

1. Physical distribution
2. Strategic alliances

In the same way that ERP is concerned with information flow, suppliers and inbound logistics, distribution management is likewise concerned with materials flow, customers and outbound logistics.

With the management of distribution, that is the physical transportation of goods from the factory to the customer, invariably some stock is held to buffer the variability of demand and supply lead times. The focus on outbound logistics is to balance customer service level against cost. Cost of distribution is not just transportation costs but also includes warehousing including special requirements such as refrigeration, insurance and financing of stock, and stock slippage (deterioration, damage, pilfering and obsolescence). The more stock that is held the greater the cost of storage and the greater the chances of losses.

The main components of distribution management are:

- Distribution strategy
- Warehouse operations
- Stock management
- Transport planning

As regards strategic alliances in order to achieve an integrated supply chain the various players need to work together. The four most important types of distribution management strategic alliances are third-party logistics (3PL), retailer–supplier partnerships (RSP), distributor integration (DI) and customer relationships management (CRM).

This building block of distribution management is covered in more detail in Chapter 9.

Systems and procedures

Systems and procedures are essential components to integrate the building block configurations of the total supply chain. There are three major categories of systems and procedures:

1. External regulatory and internal quality standards
2. Financial and accounting procedures
3. Information and communication technology (ICT)

The activities of a supply chain is affected by both national and international regulatory requirements on packaging, storage, pallets, vehicles, working hours, tariffs and many other issues. In addition an organization maintains its own quality standards and service level agreements with suppliers and partners.

Another important issue is improving the financial performance of the company. Under pressure to participate in fashionable improvement activities, or to become involved with the newest business wisdom, management may lose sight of the real issue – improving profitability. In response to pressures from stakeholders there is a risk of overemphasis on short-term financial performance. Consequently, this myopic approach results in over investment in short-term fixers and under investment in longer-term development plans. There is a need for a balanced approach.

The Internet, now taken for granted, has seen the use of technologies to create electronic communication networks within and between organizations and individuals. The implementation of ERP, websites, e-commerce, electronic data interchange and e-mail systems have allowed individuals within organizations, and business to business and business to customer to communicate freely together and to share data in 'real time'. Information technology (IT) has now grown into ICT. In this ICT domain we consider two broad areas:

1. Information technology and systems
2. e-Business

There is a visible absence of a dedicated chapter on systems and procedures in the published books on supply chain management. This building block of systems and procedures is covered in more detail in Chapter 17.

Sales and operations planning

S&OP is a cross-functional management review process to integrate the activities of the total supply chain. The classical concept of S&OP is rooted to the MRPII process. In the basic S&OP, the company operating plan (comprising sales forecast, production plan, inventory plan and shipments) is updated on a regular monthly basis by the senior management of a manufacturing organization. The virtues, application and training of the S&OP have been promoted by Oliver Wight Associates (see Ling and Goddard, 1988) since the early 1970s.

In recent years the pace of change in technology and marketplace dynamics have been so rapid that the traditional methodology of monitoring the actual performance against pre-determined budgets set at the beginning of the year is generally no longer valid. It is fundamental that businesses are managed on current conditions and up-to-date assumptions. There is also a vital need to establish an effective communication link, both horizontally across functional divisions and vertically across the management hierarchy to share common data and decision processes. Thus, S&OP has moved beyond the operations planning at the aggregate level to a multi-functional senior management review process. The traditional S&OP is a senior management review process of establishing the operational plan and other key activities of the business to best satisfy the current levels of sales forecasts according to the delivery capacity of the business.

Ling and Goddard (1988) summarize a 'capsule description of the process':

> *It starts with the sales and marketing departments comparing actual demand to the sales plan, assessing the marketplace potential and projecting*

> *future demand. The updated demand plan is then communicated to the manufacturing, engineering and finance departments, which offer to support it. Any difficulties in supporting the sales plan are worked out … with a formal meeting chaired by the general manager.*

This building block of S&OP is covered in more detail in Chapter 18.

Performance management

Performance management acts both as a driving force of improvement and a fact-based integrating agent to support the planning, operations and review processes. The foundation of performance management is rooted to quality management principles supported by key performance indicators.

There are many different definitions and dimensions of quality to be found in books and academic literature. Basu (2004) defines quality with three dimensions, such as design quality (specification), process quality (conformance) and organization quality (sustainability). When an organization develops and defines its quality strategy, it is important to share a common definition of quality and each department within a company can work towards a common objective. The product quality should contain defined attributes of both numeric specifications and perceived dimensions. The process quality, whether it relates to manufacturing or service operations, should also contain some defined criteria of acceptable service level so that the conformity of the output can be validated against these

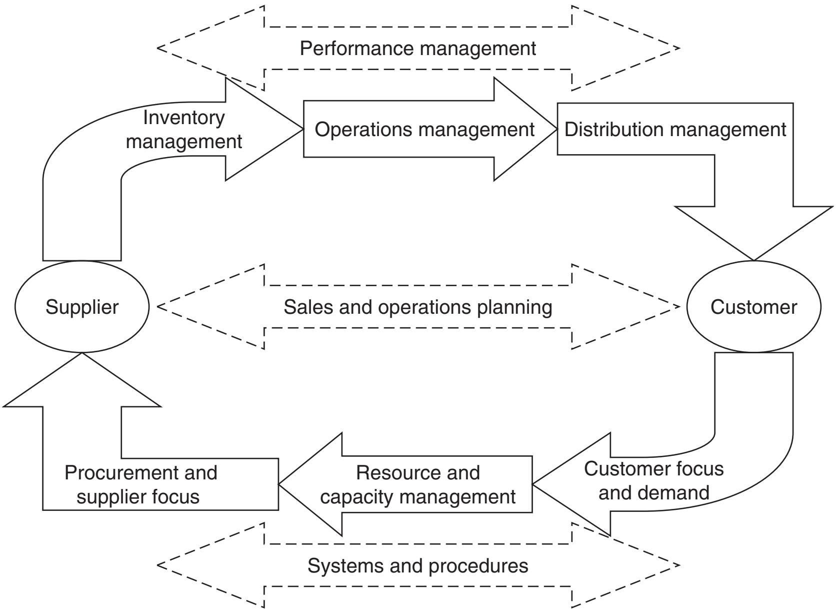

Figure 3.4 Total supply chain building blocks.

Total supply chain building blocks	
Supply chain configuration	**Supply chain integration**
• Customer focus and demand • Resource and capacity management • Procurement and supplier focus • Inventory management • Operations management • Distribution management	• Systems and procedures • Sales and operations planning • Performance management

Figure 3.5 Total supply chain building blocks composition.

criteria. Perhaps the most important determinant of how we perceive sustainable quality is the functional and holistic role we fulfil within the organization. It is only when an organization begins to change its approach to a holistic culture emphasizing a single set of numbers based on transparent measurement with senior management commitment that the 'organization quality' germinates.

A good reference line of key performance indicators of a supply chain is the 'Balanced Scorecard' by Kaplan and Norton (1996). Kaplan and Norton argue that 'a valuation of intangible assets and company capabilities would be especially helpful since, for information age companies, these assets are more critical to success than traditional physical and tangible assets'. The Balanced Scorecard retains traditional financial measures, customer services and resource utilization (internal business process) and includes additional measures for learning (people) and growth (innovation). This approach complements measures of past performance with drivers for future development.

Performance of the supply chain is covered in more detail in Chapter 19.

Are all the building blocks suited to all organizations?

Although the objectives of supply chain management, that is to balance the demand and supply for the right product or service on time and at an affordable price, remain the same for all businesses it is also true that supply chains serving different markets should be managed different ways. Both Fisher (1997) and Christopher (2000) have drawn the distinction between 'lean supply chain' and 'agile supply chain'. Agility should not be confused with lean or leanness. Lean is about doing more with less often with minimum inventory with the emphasis on efficiency. Key characteristics of an agile supply chain include responsiveness and flexibility.

As shown in Figure 3.6, the approaches for an agile or lean supply chain are determined by the volume and variety/variability. An agile supply chain responds quickly to changes in demand whether caused by a low volume for high variety products or unpredictability of demand. A lean supply chain works very efficiently when the volume is high and variability is low. The occasions for a pure agile or a pure lean supply chain are likely to be infrequent. It is a popular perception, though not always validated, that functional or commodity products need a lean supply chain and innovative and new products require agile supply chain management. As Christopher (2000) points out that there will often be situations for a 'hybrid strategy' where a combination of the two may be appropriate.

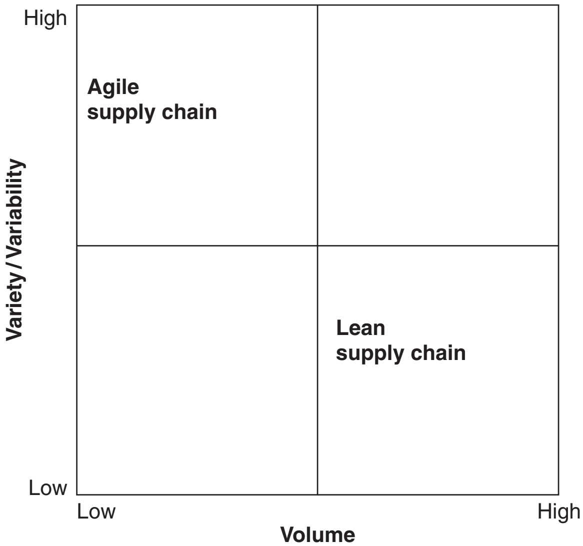

Figure 3.6 Agile or lean supply chain.
Source: Adapted from Christopher (2000).

Our building blocks of the total supply chain will apply to both lean or agile supply chains but their end objectives require different ways of using the building blocks. In a lean supply chain emphasis will be on accurate demand and capacity planning, keeping the inventory low and running the plant efficiently. In an agile supply chain the emphasis will be on high service levels by responding rapidly to end customers. This will require flexibility in process and plant capacity and a higher inventory, usually of semi-finished products, nearer the demand point.

The supply chain in the service sector will also need all the building blocks of the total supply chain although they should be used and managed differently depending on services. For example, in an insurance service industry the approach to inventory management would be different to that in an automobile manufacturing business. In the service sector the variation in demand is buffered by managing ‘non-consumed’ stock (such as people and database) while in the manufacturing sector the emphasis is on consumed stock (such as materials).

Summary

In this chapter we have explained the characteristics and roles of supply chain building blocks in total supply chain management. The building blocks consist of nine components out of which six components are for supply chain configuration (e.g. customer focus and demand management, resource and capacity management, procurement and supplier focus, inventory management, operations management and distribution management) and three components are for supply chain integration (e.g. systems and procedures, S&OP and performance management). These building blocks will be applicable, to a varying degree, to all types and strategies of supply chains whether they are primarily pull or push processes, whether agile or lean supply chains or whether they are in manufacturing or service sector.

Part 1: Introduction

Questions

1. How would you define supply chain management in a business environment? Describe in brief the major impacts of supply chain management in both manufacturing and service industries.
2. What are inbound and outbound logistics? Are there any differences between logistics and supply chain management? Discuss.
3. What is the primary goal of supply chain management? Explain the role of resource utilization/customer service (RU/CS) analysis as a first step in achieving this goal.
4. Consider the over the counter service of a fast food restaurant like McDonald's:
   (a) What are the present objectives (RU/CS) for the operation? Highlight the relative importance in a scale 1–3 (3 being most important and 1 being least important).
   (b) Identify conflicts between parameters, if any, in a combined RU/CS matrix.
5. Explain the concept of delivering value by supply chain management. Comment on the link between supply chain management and Porter's value chain.
6. Explain what you understand by 'total supply chain'. What are the components or building blocks of supply chain management?
7. What are new challenges and opportunities in supply chain management? Explain why it is necessary to consider the management of the total supply chain.
8. Describe with appropriate examples the cycle and push/pull views of a supply chain.
9. Describe the appropriate applications of supply chain strategies and processes to achieve competitive advantage:
   – The use of inventory to improve customer service.
   – How transportation can be used to increase the efficiency of product supply?
   – The increase of capacity to meet customer demand.
   – The use of information and planning to increase the responsiveness of the supply chain.

Part 2

Building Blocks of Supply Chain

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4

Customer focus and demand

Introduction

Customer focus and demand is the first of our six building blocks for supply chain management. In Chapter 3, we say customers create demand. Marketing and sales personnel and advertising agents might argue that through advertising and promotion they create demand. It is true that marketing will create interest and might initially generate some sales. But no matter how clever or entertaining advertising and other forms of promotion might be, unless the product is wanted or needed by the customer, demand will soon evaporate. A customer could be a consumer (end user), retailer, wholesaler or distributor, but ultimately the demand for a product or service is determined by the end user. An example of promotion creating interest can be seen in two West End shows opening on the same night in London. Although both might have similar sized casts and has well-known 'stars' and have the same type of promotion, one will run for several months and one will close after a few weeks. Whether a show is successful or not will be determined by the number of people who buy tickets for the show, in other words customer demand. The difference will be due to customer perception of the show not on the quality or amount of promotion. Indeed a flagging show is likely to have more spent on advertising than a successful show. Thus, although advertising and other forms of promotion can arouse initial interest if the product does not closely meet customer expectation, marketing alone cannot maintain demand. Our rule of thumb is that unless a product or service meets 80 per cent of customer needs, the customer will be lost. Why only 80 per cent? Should we not be aiming for 100 per cent and the answer is yes, but it might not be economically feasible for us to exactly meet every customer's needs or expectations, even if we knew exactly what they wanted. As a customer if we were continuously to receive service and product at 80 per cent of what we want, taking into account what we are prepared to pay, most of us would be reasonably satisfied. Organizations know this, and instinctively strive to give important customers service at a greater level than they do to less important customers, and the less important customers either through necessity or lethargy accept the rules of the game, providing the service or attributes of the product do not fall too far below what they want. Airlines do not hide the fact that first class and business class passengers get priority at check in, better service and food in flight and even better choice of movies than do economy class passengers. In reality, the reason people travel business class is for more leg room and to be able to sleep on long haul flights, rather than for the quality of the food or for the choice of wine. When was the last time that you checked the menu before buying an airline ticket? Economy class passengers all of whom would prefer to travel business class tradeoff service to reduce their cost and although the economy class passenger will have but limited expectations if their perception is that the service is poor they will, often without complaining, simply go to another airline for their next journey even if it means paying more. The lesson here is that customers do not always bother to complain or give you a reason, they just fade away.

This chapter considers how to get closer to the customer to determine what they really want and how to keep customers. In particular, the concept of customer relationship management (CRM) is explained. We begin with short section on the need to estimate demand and conclude with a short introduction to techniques for forecasting. As explained in Chapter 3 without some form of forecast of demand, management will have difficulty in establishing what the capacity of the operation is and what it should be.

What can be provided is limited by our capacity. Capacity is measured in terms of outputs, and capacity is limited by availability of resource, be it materials, people, equipment, storage space and transportation. In retail outputs will be measured by the number of items sold but sales volume might be limited by how many customers can be served in a given period. This might depend on the number of staff, the number of cashier points and the availability of stock on hand. For the West End show or for an airline the capacity will be limited by how many seats in the theatre or in the aircraft and for a hospital the limitation might be the number of hospital beds. On the other hand, for the hospital it could be that there are empty beds but the limitation might be the availability of surgeons and nursing staff, for the airline the limitation might not be the number of aircraft but the availability of aircrew. In supply chain management outputs are important and, as the words supply chain imply, the concern is with the movement of material from one component of the chain to another and finally out to the end user. The amount of material that can be held at each level will depend on physical limitations such as storage space, handling equipment, people for handling and processing, and the efficiency of the processing, information and recording systems. Likewise, how much can be handled and when it will be delivered is dependent on all of the above (stock on hand, ability to handle and process, and transport capacity and availability).

Accountants and management become agitated when they detect slow stock turns and excess capacity in the form of idle resource of space, handling equipment and people. On the other hand, not being able to meet demand and losing sales is also frowned upon! Efficient use of resource is the hallmark of a just-in-time or lean systems. The danger is when just-in-time becomes just too late. Just too late results in lost sales and lost opportunities. Successful supply chain management equates to efficient use of resource and satisfied customers. Needless to say the achievement of a balance between customer service and resource utilization is not easy. Resource and capacity planning is covered in

Chapter 5. Sufficient to say the decision on how much money to invest in stockholding, materials handling equipment, people for unloading, stacking, picking, loading and despatching together with processing, information and recording requires some form of estimate of the likely demand.

Future demand can only truly be known if the customer (and we mean all of the customers) orders in advance and the orders are firm and not speculative. It is difficult to get customers to commit to forward orders beyond the short term and consequently it is highly unlikely that we can know what the demand will be in the mid- to long term and thus a forecast will be necessary if we are going to have sufficient capacity in place to meet demand when it occurs.

It is obvious that the closer we are to the customer, the easier it will be for us to be in a position to meet their needs and to deliver on time. The effect of fluctuating demand through the supply chain, including the bullwhip phenomenon, and how to overcome and/or smooth demand fluctuations is covered in Chapter 14.

Customer focus

Our first rule is that a world class organization aims not to just make sales but to build relationships. Customers are at each stage of the supply chain and each want to receive materials that meet their needs in terms of specification, on time and at a reasonable cost … , that is right thing, right time and right price. Assuming goods delivered meet specification of each component of the supply chain, from manufacturer or processor, to distributor through wholesalers to retailers and ultimately to the end user, aims to minimize their cost of stockholding. The ideal for each component is to hold no stock and to receive goods on demand. For each downstream customer to receive such a service each upstream component, unless they in turn are getting dramatically perfect service from their upstream supplier, must hold stocks of all the stock keeping units. If a stock of every stock keeping unit is held the cost in storage, handling and funding (interest on capital invested) will be high. (In the USA, the number of goods available in supermarkets is 300,000, imagine the cost for any wholesaler who aimed never to have a stock out.) The cost of stock holding as detailed in Chapter 7 includes interest, insurance, storage space, materials handling, damage, theft, obsolescence, past used by date, fashion changes and of course the wages of staff involved in handling, counting, checking and raising orders. Thus, what the customer would like and what an organization can economically provide has to be a tradeoff between great service with high stock holding, small deliveries and high transportation costs, or lower stockholding and transportation cost with diminished customer service, longer lead times and inflexibility.

It should also be noted that at each level of the supply chain there will be additional and different needs. Downstream from the retailer, the end user will not only expect the basics (goods meet specification, available when required), but they will also appreciate after sales service and the opportunity to return goods. At the retail level of the supply chain, retailers will expect the basics (goods meet specification, available when required) plus will appreciate sharing the risk of stock holding such as provided by a vendor managed inventory system. Sharing of risk, such as using a vendor managed inventory system is explained in more detail in Chapter 14.

Determining what the customer wants means more than asking them to fill out satisfaction questionnaires, or taking them out for a cup of coffee.

Customer relationship management (CRM)

Remember the aim is to build relationships not just to sell commodities.

CRM is a relatively new term. CRM did not begin to be covered in marketing textbooks until 2002, but in effect the concept was well known for decades before this. In essence, it is a proactive approach to understand who your customer is, their strengths and weaknesses as well as their direct needs with your organization.

From an accountants approach information is gathered to determine which customers are profitable and which are not including how much is being given away in discounts, transportation costs and the profit margin per line item. Basu and Wright (2005) relate that in one organization they encountered that the top 5 per cent of customers accounted for 40 per cent of the sales, and because of their perceived importance were able to negotiate volume discounts and special delivery agreements. When these special conditions were examined it was found that the balance of the customers were providing the company with a true 40 per cent gross profit on sales and that the top five per cent of customers were only providing a gross margin on 10 per cent. Thus, overall the gross margin for the company was reduced to 28 per cent. This had not been apparent as the annual accounts had shown discounts and transport costs as general expenses and not as costs of sales. From a marketing point of view CRM is used to identify needs of customers, demographics and market segmentation, and to promote customer loyalty. From a supply/operational aspect CRM provides information of past demand, trends and seasonal patterns. In short from past history CRM indicates when periods of heavy demand are likely to occur.

The CRM system requires information to be gathered and stored on a database for each customer, and for the database to be readily accessible across the whole organization. Thus, each function will be using and making decisions based on common data. The database will have records of what each customer is buying and when (seasonality of demand). For retail customers such information can be gathered through loyalty cards (see Chapter 14). Information collected can show individually or for a group of customers what they are buying and when and if sales to a particular customer, or group of customers, is profitable. Direct marketing information is gathered through sales staff from call reports, quotes and orders lost. And of course the customer should directly be canvassed as to what they want from their supplier. In some circumstances important customers can be involved in research and development for new products. Other information for the CRM database can be gathered, without the customer's awareness that a database is being built, from customer annual reports, media statements, and comments by analysts in the business pages of newspapers and journals. For large (important) customers this would include tracking the share price.

The CRM database system allows information to be retrieved quickly and is invaluable in forecasting demand and seasonality of demand. It also helps if the customer can be enlisted in providing early advice as to what their own budgets and forecast of demand are likely to be. If a supplier can get close to a customer, and if there is mutual trust, the customer and supplier can jointly plan for forecasted demand. A component half-way up the supply chain, such as a distributor should be working closely in the guise of being a customer with their major suppliers in much the same manner as they are working with their major customers. It is not enough to know the strengths and weaknesses of your direct customers, but a supplier should have market intelligence right out to the end user, and in the CRM file for each customer, information regarding their customers should also be gathered. A macro and micro approach is needed.

Not one sided

CRM if properly applied allows us to know our customers and to know their market. The aim is to get close to the customer so as to build a long-term relationship. But gathering information should not be one sided! We need to share information with our customers. Long-term partnerships take time to build and require trust and respect. A full trusting partnership would include sharing technical information and market intelligence. Instead of the old, almost adversarial, approach with customers driving a hard bargain and with suppliers hiding material prices and labour costs and adding on hidden margins where they could, benefits can be gained for both supplier and customer through jointly working to reduce costs and to improve relations.

Pestle

In forecasting knowing your direct customer and your direct supplier is a start, knowing their suppliers and customers is also important, but understanding external factors as normally covered in the strategic managers PESTLE analysis is also important. PESTLE stands for Political, Economic, Societal, Technological, Legal and Environmental aspects which could impact on the organization, and each is examined as a threat and as an opportunity:

- *Political*, *legal and societal factors*: Laws and regulations might seem to be tiresome limitations, but they do provide protection and a measure of stability. For our home market we will know what is legally acceptable, hours and conditions of employment, health and safety issues, taxation and regulatory requirements. When operating overseas, it is wise to understand that what is acceptable in one country may not be acceptable in another. With overseas trading partners stability of government has to be taken into account when importing or exporting. At home it is necessary to understand the policies of the government of the day and of the major opposition parties.

- *Economic* factors include the state of the economy in general including interest, unemployment, inflation and foreign exchange rates and likely movements.
- *Socio-cultural* includes the movement towards triple bottom line accounting for environmental and sustainability including social issues as well as the traditional economic and financial bottom lines. The impact on the supply chain of pressure from the environmental green movement with their concerns, real or imagined (such as global warming) is given in Chapter 15.
- *Technological changes*: In the supply chain technology plays an important part. It is true to say that the supply chain of today would not function without information technology to provide point of sale, electronic data interfaces, electronic funds transfer, manufacturing resource planning, enterprise resource planning and of course the focus of this chapter, CRM. The e-supply chain is fully explored in Chapter 13.
- *Technology* includes more than information technology, it includes handling and stacking equipment, packing material, storage, tracking with radio frequency identification (RFID) and bar coding. In manufacturing it includes computer aided design, automation and robotics. All these areas are touched on in elements of Chapters 5, 7–9 and 14.
- *Competition*: It is not normally shown in a PESTLE but is very important. Competition is where your customers can go! Identifying and understanding the competition, what they are doing and what they are threatening to do is essential. However, it is dangerous to overreact, what the competition says it can do, or will do, may not be quite the same as what actually happens. In essence, the very least an organization can do is to meet the service level provided by the competition, and to recognize that your performance is judged against customers perceptions of world class standards and, rather unfairly, customers will be swayed by hyperbolic claims of the competition. The following questions are designed to help an organization to understand threats and weaknesses of the competition. These questions are adapted from Basu and Wright (2005):

1. How well do you know the true market size and share for your product/service?
2. Who are your three main competitors?
3. How good is your knowledge of the strengths and weaknesses of your top three competitors?
4. How well do you know and compare the service level your competition provides?
5. Do you actively monitor your competitor's acquisitions, expansion and divestments?
6. Do you know the capacity of your competitors manufacturing and distribution centres?

7. Do you regularly benchmark your performance against the competition?
8. Do you have a dashboard of key performance indicators for your supply chain?

Performance measures in supply chain management can include return on assets employed, stock turn, on time delivery, transportation costs and other costs and measures as explained in Chapter 19.

Techniques for forecasting demand

The three approaches for forecasting are:

1. Qualitative
2. Quantitative (mathematical or time series approach)
3. Causal

In reality, all three approaches are interlinked and should be taken into account when determining a forecasted demand figure. Invariably, all forecasts will also have an element of subjectivity associated with them.

Qualitative forecasting

Qualitative forecasting uses judgement, past experience, and existing past and present data. However, if forecasting on past results and based on current conditions was easy, the bookmakers would soon be out of business and the weather forecast would always be right! Relying on past information alone to forecast the future is like driving a car forward by looking back through the rear view mirror.

The best-known methods of qualitative forecasting are:

- Expert opinion (including scenario planning and the Delphi method)
- Market surveys
- Life cycle analysis

Expert opinion

Individuals or groups can undertake this method. If we think about it, managers use expert opinion all the time as they plan and make decisions every day. Scenario planning consists of creating hypothetical circumstances that may happen in the future, and then formulating solutions to each scenario. Trend analysis and understanding causal factors is essential to good scenario planning (Getz, 1997).

Imagination is required, as the event manager should then determine the impacts on forecasts using these different scenarios.

As explained in Tum et al. (2005), another method of using expert opinion is the Delphi model. Delphi is named after the city in ancient Greece, which was the site of the most famous and powerful oracle in the temple of Apollo, noted for giving ambiguous answers. The approach was that if the supplicant asked the right question they got the right answer. A priestess spoke the oracular messages whilst in a frenzied trance, and sitting on a golden tripod. A priest would interpret these sounds to the supplicant usually in verse. People seeking help would bring gifts to the oracle, and the shrine became very wealthy. Nowadays, the Delphi method is considered by many to be the most successful of the qualitative methods, although it could hardly be considered useful if it were ambiguous. It is time consuming and costly, and is best used by large organizations. The method uses a set of questions to a group of managers or 'experts' who, working without collusion, give their individual opinions. A coordinator then tabulates the opinions, and if individual results differ significantly then the results are fed back anonymously to the panel with a further set of questions. The process is repeated until consensus is reached. Questions and feedback generally continue for four rounds, with the questions becoming more specific with each round. The benefit of the method is that a group opinion can be achieved without the team meeting. This overcomes one of the weaknesses of a face-to-face group meeting, where it is possible for members to be swayed by a dominant member, or perhaps an 'expert' member may be embarrassed to back down from a publicly stated opinion.

Market surveys

Market surveys are generally not used to forecast demand for capacity management. They are best used to determine why a product or service is not performing as well as expected. Market surveys collect data from a sample of customers and potential customers, analyse their views and make inferences about the market at large. Wright and Race (2004) advise that surveys can be carried out by telephone, personal interview, surface mail or e-mail. Market surveys use two approaches: structured and unstructured. With the structured approach the survey uses a formal list of questions. The unstructured approach enables the interviewer to probe and perhaps guide the respondent. The survey enables the manager to learn why people did not buy, and gives the potential for attracting new segments in the future. Framing of questions is an art, and when the questions are completed they should be tested to check ambiguity and relevance. The key is to establish from the outset exactly what information is wanted, and then to design questions that will give the required information. Questions that are not relevant to the issue are a waste of time and money. A weaker form of market survey includes group interviewing or focus groups. With the focus group approach, six to ten people are invited from a market target group to a meeting. The conditions are relaxed with refreshments and so on, and after the interviewer has set the scene it is hoped that group dynamics will bring out actual feelings and thoughts. At the same time the interviewer attempts to keep the discussion focused on the subject of the research. The concern with this approach is that too much can be read into the opinions of a small and possibly non-random sample. Holding several focus group meetings on the same subject and then pooling the results can to some extent overcome this problem.

Life cycle analysis

It is generally accepted that products and services have a time-based life cycle. The stages of the life cycle are development, launch, growth, maturity and decline. In preparation of the launch stage it will be necessary to have stocks of product at each level of the supply chain to make the launch a success, and likewise for the growth stage where there might be a rapid growth in demand. Once a product reaches the maturity stage, the demand will be relatively stable. For most types of products life cycles are readily predictable and the rate of growth/decline will not be unexpected. Experienced marketing managers can often, with some degree of accuracy, forecast how long a product will stay in each stage of the life cycle. In the fashion industry in particular the demand will be seasonal and for each new season product will be manufactured and stocked in the previous season. In Chapter 14, the example is given of a chain of retailers having to order 11 months in advance.

Quantitative

Time series forecasting

Time series forecasting uses mathematical analysis of past demand trends to forecast future demand. However, the accuracy of a forecast will not be known until after the event, and this is usually monitored by the deviation of the actual result from the forecast result. Short-term forecasting involves taking historical data of demand patterns from a few past periods and projecting these patterns into the future. The simplest method is to take the last period's actual demand and use it for the next period(s) forecast, this method gives a quick response to a trend; if the trend is upwards then the forecast will be upwards, but may lag behind. If, however, there are marked annual fluctuations, with this method, following a buoyant year, forecast higher demand. An example of forecasting using seasonal trends is given in Table 4.1.

This method gives a quick response to a trend; if the trend is upwards then the forecast will be upwards, but lagging behind. If, however, there are marked seasonal fluctuations then this method, following low winter sales, would forecast low spring sales although it is well known that for this product spring sales will always be higher than winter demand. In the above example, based on actual results, the forecast for period 5 (spring) is 18 although past history shows that spring sales are always about 33 per cent above winter demand.

Forecasting by past average

This method is to average all of the past results (see Table 4.2).

Table 4.1 Forecasting using seasonal trends

Period	Forecast demand (based on last period)	Actual demand	Deviation
1	No prior data	20	
2	20	22	−2
3	22	23	−1
4 (winter)	23	18	+5
5 (spring)	18	24	−6

Table 4.2 Past average

Period	Forecast	Actual	Deviation (forecast to actual)
1	–	20	–
2	20	22	−2
3	21	24	−3
4	22	23	−1
5	22	13	+9
6	20	9	+11
7	18	8	+10
8	17	6	+11

A refinement is to take a moving average. In Table 4.3, the last three periods are averaged. This method provides a response to trends, and also dampens fluctuations. Although there are still significant variations shown in Table 4.3, the forecasts for periods 7 and 8 are more accurate than those shown in Table 4.2.

Total absolute deviation (TAD) is the sum of all the deviations ignoring plus or minus signs. Mean absolute deviation is the average of the deviations. In this example, although there are five forecasts and five deviations (actual to forecast), the sum of all the deviations ignoring plus or minus is 35. Plus or minus is ignored as it is just as serious to over forecast as it is to under forecast demand. In this example after the first forecast which was reasonably accurate the variations are significant. For example, for period 6 the forecast is 222 per cent of actual demand. Although using averages of past actuals 'dampens' rapid responses when there are fluctuations, the method is slow to respond when there is a definite trend, either up or down.

The number of periods used for averaging is a matter of judgement. If there are definite cycles the number of periods in the cycle can be used to determine the number of periods used for averaging.

Seasonal adjustments

Where there are distinct seasonal trends then the forecast can be further refined by adjusting for seasonality.

Table 4.3 Three period average forecast

Period	Forecast	Actual	Deviation (forecast to actual)
1	–	20	–
2	–	22	–
3	–	24 (66/3 = 22)	–
4	22	23 (69/3 = 23)	−1
5	23	13 (60/3 = 20)	+10
6	20	9 (45/3 = 15)	+11
7	15	8 (30/3 = 10)	+7
8	10	16 (33/3 = 11)	−6
	Total absolute deviation		35
	Mean absolute deviation 35/5		7
	Deviation spread	= +11 to −6 = 17	

In Table 4.4, we can see that on average the first three quarters each year have accounted for 82 per cent of the total demand for the year. Therefore based on the previous years history the actual demand of 30 + 55 + 60 which totals 145 will likely be 82 per cent of the full year. Thus the full year will be 176.8 and quarter four will be 31.8. This can be checked for trend. Each year the total demand has increased; from 2004 to 2005 by 17 per cent, 2005 to 2006 by 16 per cent, 2006 to 2007 by 9 percent and if our forecast for 2008 is correct the increase will be 8 per cent.

However is the forecast of 176.8 sensible? 176.8 is a very exact figure and we must remember that a forecast is seldom exactly correct. We should therefore forecast 175 or if the omens are goof 180. We would need to take into account market and economic trends and indicators such as unemployment rates, interest rates, currency exchange fluctuations, the political situation and of course what the competition is doing or threatening to do.

Table 4.4 Seasonal adjustment

Year	2004	2005	2006	2007	2008
Quarter One	15 (14%)	22 (17%)	25 (17%)	28 (17%)	30
Quarter Two	35 (32%)	40 (31%)	45 (30%)	52 (32%)	55
Quarter Three	40 (36%)	45 (35%)	50 (33%)	54 (33%)	60
Quarter Four	20 (18%)	22 (17%)	30 (20%)	30 (18%)	?
Full Year	110	129	150	164	??

We now have a forecast for the next 12 months (four quarters) which is seasonally adjusted and which has allowed for growth based on the past trend. Naturally as each new ‘actual’ comes to hand we recalculate our moving forecast.

The main weakness of using past averages is that equal weight is given to each of the historical figures used, and it is also necessary to have, or to build up, a history of information to test against and to forecast from.

In general there are two frequently used models for time series forecasting:

1. Moving averages
2. Exponential smoothing

The moving averaging model, as shown in the example in Table 4.3, uses the average of the past period data in a time series to forecast future activities. In another simple example, assume the sales of the last 4 months of a mobile handset is 10,000, 12,000, 11,500 and 13,000. Then using a 4-month moving average, the forecast for the fifth month would be the average of the past 4 months, that is (10,000 +12,000 +11,500 +13,000)/4 or 11,625.

Exponential smoothing is similar to the moving average methods but it eliminates some of the calculations. The model uses a smoothing factor (less than 1) for forecasting the next period activity. The mathematical formula is

$$F_{n+1} = aA_n + (1 - a)F_n$$

where F_{n+1} is the forecast for next period,
F_n is the forecast for the current period, a is the smoothing factor and
A_n is the actual data for the current period.

Causal

Causal forecasting is when an event (such as sales) is caused by some other event. For example, the demand of small cars increases with the increase of the petrol price. In forecasting, it is easy to get caught up with the method of calculating and to overlook the purpose. The purpose is to get the best possible forecast of what might happen in the future. Past results must be examined to understand why fluctuations in past demand occurred. For example, what was the state of the economy, noting key indicators such as interest rates, inflation rates, currency exchange rates, employment rates and factors such as the entrance of new competitors, new technology and materials, fashion trends, and marketing drives. Knowing the past causes for changes in demand is important when making forecast for the future. Although the information used has a quantitative source, the application and usage of the data relies on a qualitative interpretation.

Common sense

Finally, the commonsense approach with forecasted figures is to test by asking, are these figures sensible, what happened before and what is likely to happen in the future? This approach shows the link between the use of quantitative data and a qualitative approach, and uses the experience, knowledge and expertise of the management team. As Wright and Race (2004, p. 161) say ‘the commonsense approach with forecasted figures is to test them by asking

"Are these figures sensible, what happened before and what is likely to happen in the future?" Once the future demand forecast has been agreed then we must determine the future capacity of the organization, and anticipate what changes might be needed to meet the level of forecasted demand'.

Factors affecting forecast errors

Forecasting is a multi-function review process and marketing should own the responsibility of agreed forecast data. There are many factors as shown below affecting the accuracy of a forecast and marketing is involved in most of them. The key factors are:

- Internal organization factors
  - Historical sales performance of the product
  - Product marketing and promotion
  - Introduction of a new product
- Macroeconomic factors
  - Interest rates, exchange rates and inflation
  - Political climate and government regulations
  - Employment rate and industrial relations
- Market intelligence factors
  - Competitors' performance and strategy
  - Market share and market saturation
  - Reputation for quality

Case example: Reputation for quality

Ford Motor Company's Explorer sports-utility vehicle had a huge recall in the middle of 2000 primarily because of faulty tyres used. The recall was a consequence of many fatal accidents linked to Firestone tyres used in those vehicles. Firestone tyres, supplied by the Bridgestone company of Japan, directly suffered a loss of confidence in all ranges and resulted in poor sales of Ford's sales also suffered.

Adapted from Waller (2002, p. 266)

Summary

In summary, we conclude this chapter with questions derived from Basu and Wright (2005) designed to enable an organization to understand their customers and their customers needs:

1. How well do you know the relative importance of your main customers?
2. Is your CRM database up to date and is it readily accessible to all key members of your organization?

3. How often do you conduct market research of trade and customer needs out to the end user?
4. How well are customer complaints handled and recorded?
5. How is customer satisfaction measured (on time delivery, accuracy of delivery, lead time, order fill, after sales service)?
6. How close is your link with internal functions of marketing, planning and operations?
7. How close are your links and sharing of information with other components, upstream and downstream in the supply chain?
8. Are staff other than sales and marketing encouraged to meet with customers?
9. How well are you aware of opportunities and constraints of the emerging markets such as India and China?
10. How closely is your operations manager involved with customers to achieve a good understanding of customers needs?
11. Do you have a serious partnership with customers to help them gain a competitive edge?
12. How frequently do you analyse channels of distribution up- and downstream in the supply chain?

To be world class we have to know our customers and know what they want, remember we are building relationships not selling commodities. Without customers any organization, profit or non-profit will not survive. We also have to understand that for any commercial organization profit is necessary for survival. The level of customer service provided must be affordable and sustainable. Our final comment, the objective should be to build long-term relationships, not to be just making sales and short-term gains.

5

Resource and capacity management

Introduction

This chapter shows why resource and capacity management is an important building block in supply chain planning and management. We begin by explaining what effective capacity is as opposed to theoretical capacity. The objective for capacity management is to meet demand, and thus we show that the effective capacity for a complete supply chain is how many units could be supplied in a specific time period such as a daily basis to end users if required. The supply chain consists of many stages from preparing the ground and sowing the seed out to the final consumer, and from seed to mouth might take 12 months or longer. Unless you are a supermarket group such as Tesco's or Sainsbury's it would be rare for any one player to be able to control the complete supply chain; therefore, it is more practical to consider how each component can manage their part of the supply chain while working closely with immediate supply and customer partners. In this chapter we consider how any one component of the supply chain can efficiently manage their level of the supply chain.

- Capacity forecasting and planning
- Materials and manufacturing requirement planning
- Production scheduling
- Enterprise resource planning (ERP)
- Capacity adjustment to meet demand
- Demand manipulation
- Operations scheduling

Theoretical capacity

In supply chain management capacity refers to the amount of inventory that can be held in the supply chain. The aggregate capacity is the sum of the total inventory that could be held simultaneously at each stage. In theory this total is the capacity of the entire chain. However, a supply chain does not stand still, material is constantly moving into the factories and food processing plants, is being transported by road, rail, sea and air, sometimes in large amounts (e.g. a 100,000-tonne oil tanker or other bulk carrier) and through successive stages out to the end user.

Effective capacity

The effective capacity can be defined as the amount of material or product available at *each* upstream stage of the supply chain. Beginning with the end user, how much could the upstream supplier provide at any given time to customers and so on up through the various tiers of the chain? Some texts measure capacity in the supply chain based on the capacity of warehouses, in the sense of how much can physically be stored. While storage space might be a concern if you are the manager or owner of a warehouse the effective capacity is how much can pass through your warehouse in a given period, rather than how much you can physically store. Movement through the warehouse will be limited by the speed and reliability of inward supply and by the availability of outward transport. The objective of good warehouse management is not to have huge amounts of material, but to have a high rate of throughput. Dangers and costs of large stocks of slow-moving stock at any stage of the supply chain are:

- Cost of premises
- Cost of capital (interest on cash tied up in stock holding)
- Handling costs
- Insurance
- Damage and deterioration of materials
- Stock shrinkage due to miscoding and theft
- Loss due to obsolescence, fashion changes and passed used by dates

Thus, the effective capacity is measured in terms of throughput for each stage of the supply chain. At the end of the supply chain effective capacity is the amount of finished product that can be supplied to end users on a daily basis. For example, in the military capacity could be measured by the number of rounds of ammunition, or the number of ration packs that could be supplied daily to the front line. Capacity is not the number that is supplied, but the number that *could* be supplied if required.

Capacity forecasting and planning

Wild (2002) says 'Capacity management is concerned with the matching of the capacity of the operating system and the demand placed on that system'. Planning to match demand and capacity begins with the forecasting of what the demand is likely to be.

Capacity decisions are based on forecasts of demand at several different levels. Long-range capacity planning needs forecasts to be made several years ahead and includes facility planning. Short- and medium-term forecasts span 2–3 years, and generally are used to determine people requirements, leasing of premises, machines and equipment, and product details. In the more immediate short-term forecasts are used to plan, order and schedule resources on a monthly, weekly and daily basis. The shorter the time frame, the more precise the forecast must be.

As discussed in Chapter 4, in long-term forecasting past experience and trends will be factored into the calculations. In considering the past numbers alone are not sufficient, as the numbers will merely reflect a variety of circumstances that influenced or determined the outcome. Establishing circumstances or events that shaped past demand will not be easy as it cannot be certain that all the facts will be remembered or that they will occur again in the same way. The danger for statisticians and forecasters relying on the past is not knowing the circumstances and on relying on the numbers. Obviously, for some industries and products seasonal trends might well provide a reasonably accurate forecast.

In the short term if orders are made in advance, if market trends are apparent and if all components of the supply chain are sharing information actual demand should be readily known. In Chapters 2 and 14, we discuss the bullwhip effect which refers to poor information sharing resulting in panic ordering and over reaction with wildly fluctuating demand. Assuming that the bullwhip effect can be mitigated, and this is discussed in Chapter 14, knowing what the actual demand will be a week, a month or even 3 months in advance gives little scope to substantially adjust capacity. Machinery cannot be added over night, it takes time to recruit and train new staff, additional warehouse space takes time to find and to fit out, etc., and often transport has to be booked well in advance. Short-term adjustment of capacity is often more reactive than proactive.

Types of forecasts

As discussed in Chapter 4, there are three ways of looking at forecasts: the qualitative approach, the mathematical or time series approach, and the causal approach. In reality, all three are interlinked and should be taken into account when determining a forecasted demand figure.

Example: Qualitative forecast

Past history shows that it is unlikely that England will win the next Football World Cup. This does not prove that they won't!

Last quarter (spring) the demand was twice that of the previous (winter) quarter. Further examination might show that the trend for the last few years that demand in the spring quarter has always been double that of the previous quarter (winter). However, the circumstances existing each previous spring might have influenced the results. For one year demand might have been high due to a new product launch, another year the high demand was due to a successful TV promotion, and on another occasion a major competitor might have failed and we got the business by default. The figures cannot stand alone but need to be supported by information as to the circumstances at the time.

Example: Life cycle analysis

The product life cycle curve of develop, launch, growth, maturity and decline is shown in Figure 5.1. It is generally accepted that products have a life cycle which is time based. At the launch stage demand is low, the growth stage shows a rapid demand increase and relatively stable demand at the maturity stage. Most product life cycles are predictable and for a product such as petrol the life cycle has extended over many decades but for some fast-moving consumer goods and fashion items the rate of growth/decline can be dramatic. Some consumables only reach the decline stage if there is a dramatic change in technology. An example is the replacement of canned vegetables such as peas by frozen vegetables. However, once the decline has steadied there is still a demand (easily forecast) for canned vegetables. Managers who have a history of experiencing the introduction of new products can be expected to forecast with a reasonable measure of accuracy how long a fashion will take to pass though each stage of its life cycle. Where there is an obvious life cycle capacity decisions can be made, such as ordering and holding materials during the growth stage in anticipation of a high demand in the growth stage.

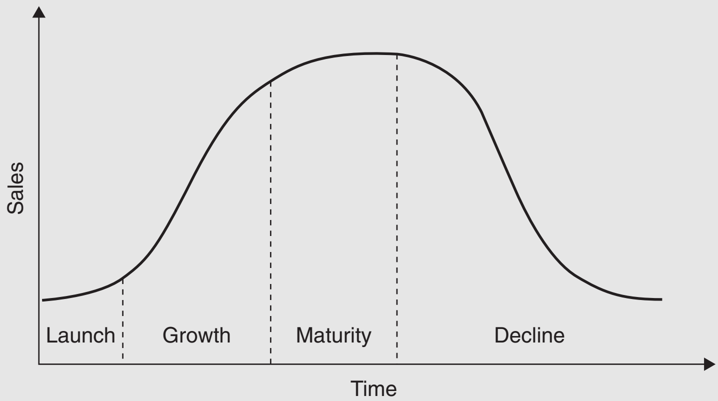

Figure 5.1 The product life cycle.

Example: Time series forecasting

Forecasting by time series employs analysis of past demand and trends of demand to anticipate future demand. Any forecast or method of forecast can be tested for past accuracy. Accuracy is usually monitored by the deviation of the actual result from the forecast result.

Short-term forecasting considers historical data patterns (of demand) from past periods and projects these patterns into a forecast. Thus, if last period demand was 50,000 the forecast for the next period would be 50,000. If for each period the trend is upwards then the forecast will follow the trend but always lag behind (see Table 5.1).

Table 5.1 Short-term forecasts

Period	Forecast	Actual	Deviation
1	45,000	50,000	+5000
2	50,000	55,000	+5000
3	55,000	45,000	−10000
4	45,000	40,000	−5000
5	40,000	45,000	+5000
Total absolute deviation			30,000
Mean absolute deviation			6000
Deviation spread (from −10,000 to +5000)			15,000

The method gives a quick response to a trend, depending on the length of time of each period. If the trend is upwards then the forecast will be upwards but lagging behind. The total absolute deviation in the above example. This indicates that having a higher forecast than actual is as serious as having a lower than actual forecast. In the calculation of total absolute deviation the symbols for plus or minus are ignored. The mean absolute deviation in Table 5.1 is the average deviation of forecast from actual and in this case the forecast on average is ±6000 wrong on each occasion. If the forecast is too high it is likely that too much resource will be provided, and if too low there will not be sufficient resource to satisfy demand. If the periods shown above are daily forecasts and the resource is not perishable the damage in poor forecasting might not be great. If however each period represents a year the damage done could be serious. If the industry is seasonal then this method would, following a buoyant autumn, forecast high winter sales, when in fact past history shows that winter sales will always be lower than autumn sales. This is better illustrated in Table 5.2.

Table 5.2 Seasonal trends (figures in $ '000,000)

	2004	2005	2006	2007	2008
Quarter One	20 (11%)	22 (11%)	21 (15%)	26 (11%)	31
Quarter Two	40 (22%)	45 (22.5%)	18 (13%)	52 (22%)	62
Quarter Three	40 (22%)	44 (22%)	28 (20%)	52 (22%)	?
Quarter Four	80 (45%)	89 (44.5%)	75 (52%)	105 (45%)	?
Total	180	200	142	235	?

In Table 5.2, it can be seen that apart from 2006 there is a very obvious seasonal trend. Quarter One is 11 per cent of the total demand for a year, Quarter Two 22 per cent, Quarter Three 22 per cent and the fourth Quarter is on average 45 per cent. Obviously, something went terribly wrong in 2006. As we are now only in the first half of 2008 it should be easy to find the reason for the 2006 aberration. It could simply be due to the product life cycle and that the competition was able to steal a march on us with an updated product, and it was not until the end of the year that our new product came on line. Or if we were in an overseas market there might have been a natural disaster such as a tsunami or earthquake in 2006 which disrupted our supply lines. Once we understand what went wrong in 2006 we can with some confidence predict that the first two quarters of sales will be 33 per cent of the full year and thus the full year forecast will be 281.8. We would never forecast 281.8, as this suggests an exactitude that could not happen. Thus we would either say 280, or if the economy was buoyant we would say 285, but never 281.8!

Supply chain management is distinguished by its role to provide a strategic and integrating function at all levels of logistics including the suppliers. Ideally, the supplier becomes part of the team and is involved in the planning process, not only for scheduling of deliveries when required, but also in the design stage for new products. The business objective to convert customer demand by optimizing the utilization of resources to deliver effective customer service applies to all organizations regardless of whether they are in manufacturing or service sectors.

Materials requirement and resource planning

In most manufacturing companies the focus is on a reliable flow of inwards materials. This is achieved through a materials requirements plan (MRP) for inbound logistics so as to achieve an appropriate balance of stock and to satisfy demand.

MRP is the set of techniques which uses bills of material, inventory on hand and on order data, and the production schedule or plan to calculate quantities and timing of materials. Such a plan is incomplete if it does not take into account whether manufacturing resources (e.g. plant, people, energy and space) will be available at the desired time.

Manufacturing resource planning (MRPII) arose from an appreciation of the need to time and phase materials with resource availability so as to achieve a given output date. MRPII is an integrated computer-based system. A computer-based approach is essential due to the amount of data required. Various software systems are available, each based on the same principles. MRPII is depicted in Figure 5.2.

With MRPII, the planning process arises from the innovation of new products and the strategic marketing plan. Starting with this information a business

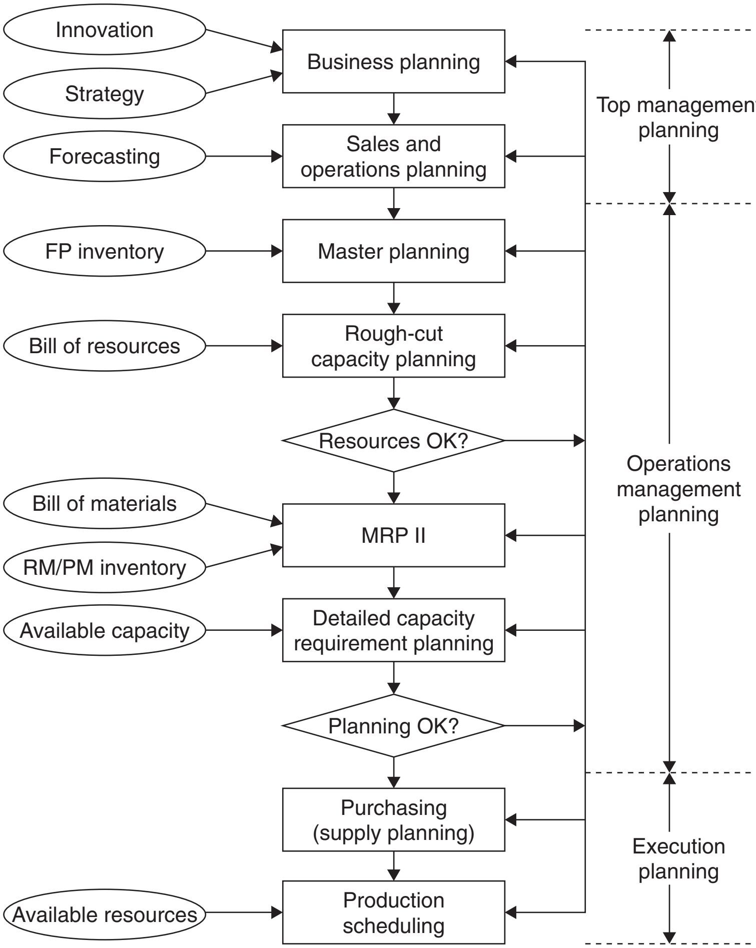

Figure 5.2 Manufacturing resource planning.

plan is constructed to determine and communicate estimates of the sales volume of each product range. The business plan should be developed at least once a year and during the year periodic updates will be required.

From the business plan, an operations plan is formulated which covers the materials and other resources needed to translate the business plan into reality. It follows that to keep the operations plan in line with updates to the business plan, regular communication is required between the various functions involved. This updating process is best achieved by face-to-face meetings which we recommend should take place at least once a month and always with all parties present at the one time. There is a very real danger of misunderstandings and ambiguities if meetings are not face-to-face and if all concerned are not present at the same time. Meetings need not be long drawn out affairs. From experience we believe that any planning meeting that takes longer than an hour is wasting time. The key managers at these meetings will be from sales, operations and planning. The issues that will be agreed will include time and availability of resources, and conflicting requirements and priorities will be resolved. Above all demand is the crucial issue, and as future demand can never be certain there should be a formal mechanism of forecasting using the best combination of historical models, past results from promotions, data from customers and market intelligence. Likewise, the inventory data system has to be up to date and accurate with details of raw materials (RM) on hand, goods on order, lead times and finished goods on hand.

Only with up-to-date information, and with the continuous review and management of information, can an organization hope to achieve a balance of resources and stocks of inventory to meet planned service levels. The master planning and production scheduling process therefore has to be continuously monitored and updated to ensure that this occurs.

Production scheduling

The master production plan or master schedule is at the heart of MRP where both the timing and quantity of orders are determined from offsetting from the current stock the demand during the lead time to meet the master production plan.

As shown in Figure 5.3, the concepts of MRP underpinned by the master plan can be extended also to the distribution channel to allow integrated scheduling throughout the supply chain. The approach of distribution requirements planning (DRP) is compatible with MRP as used in the factory.

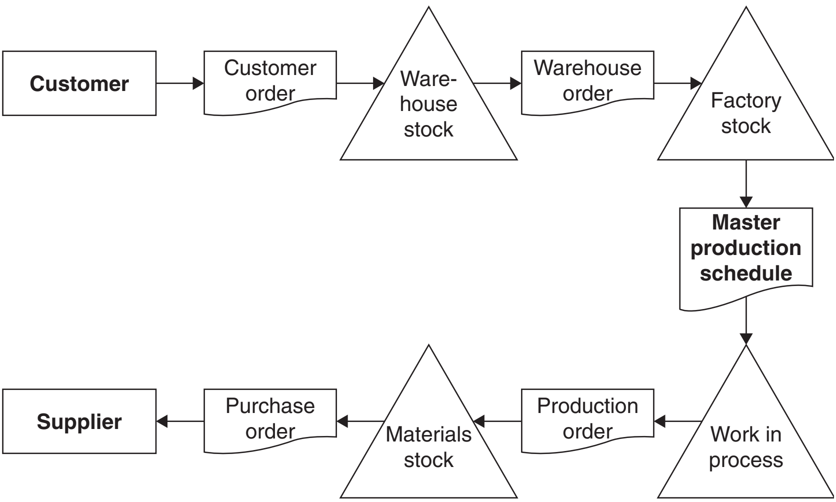

Figure 5.3 Order flow in MRPII.

The next stage is to follow a rough-cut capacity planning process to assess to what extent the capacity of manufacturing facilities could meet the master schedule. The feedback loop at this level tests the master plan against problem areas such as known bottlenecks and other critical resource areas. Often, as this is a short- to medium-term approach, action has to be taken to make the best use of existing resources rather than to add extra long-term resources. The company should decide which alternative to follow if the existing resources are not adequate, for example review the schedule, increase resources, work extra shifts, delay maintenance, outsource to third parties and so on. With computer systems it is relatively straightforward to simulate using 'what if' scenarios to evaluate alternative courses of action.

Having established that the resources are sufficient, or having adjusted the plan to fit the resources, then the next step is the detailed MRP and the detailed capacity requirements planning for day-to-day operations. This stage includes the production of detailed bills of materials for each product or batch of products. With the revised master schedule for each product and for each stock keeping unit (SKU) and bills of material for each SKU, the materials required for each item of raw materials (RM) and packaging materials (PM) are then matched with the current inventory levels to derive the additional procurement requirements. The requirements are modified, if required, after comparing with the detailed capacity planning process.

The execution of the planning process then commences with the final production scheduling and purchasing (supply planning) processes.

We have outlined a generic description of the MRPII process. There are of course variations – more significantly between batch production processes and continuous production processes and between so-called 'push' and 'pull' demand systems. With the 'push' system stocks of materials and of finished goods are used to ensure maximum plant capacity utilization by having level production. The 'pull' system is driven by customer orders and just-in-time principles which can result in some under utilization of capacity. It is said that just-in-time requires greater flexibility and reliability of plant plus a multi-skilled workforce. In its simplistic form just-in-time is reactive (demand pull), whereas MRPII can be described as proactive. MRPII looks forward and determines what will be needed to achieve a desired output date. Internally MRPII is a push system; inventory is driven through the process by the schedule. Thus, the customer requirements are linked to the resources and materials necessary so as to precisely meet a just-in-time delivery date. From a customer's point of view it could be argued that as long as the goods arrive on time and meet the specifications, the system used by the manufacturer is irrelevant!

To be effective, MRPII has to be an integrated computerized system and should be on-line and accessible to all interested parties. It follows therefore that data has to be kept up to date on the system. For example, if engineering changes are made to the design of a product the MRPII database has to be updated otherwise the bill of materials for procurement purposes will not be in line with the new design. It is clear that MRPII cannot be effective unless a 'single set of numbers' is used by all functions (i.e. marketing/sales, finance, manufacturing, human resources (HR) and information technology) of the organization or enterprise. This has led to the migration of MRPII to ERP.

Enterprise resource and operations planning

ERP replaces the old standalone computer systems for finance, manufacturing, HR, and distribution and replaces them with a single integrated software system divided into software modules that approximately represent the old standalone systems. The growing market of ERP systems is dominated by SAP R/3 and followed by Oracle, PeopleSoft, Baan, JD Edwards and MfgPro. It is fundamental to note that if you simply install the software without rationalizing the processes or changing the way people do their jobs you may not see any value at all.

ERP in service enterprises

There are five major factors why companies undertake ERP systems:

1. Integrate financial information
2. Integrate customer order information and demand plan
3. Standardize and speed up supply processes
4. Reduce inventory
5. Standardize HR information

It is true that ERP is basically a second-generation MRPII system which is predominantly in manufacturing organizations. However, if we consider the above five reasons from the standpoint of a service organization we see that all factors, arguably with the exception of 'reduce inventory' are applicable to justify an ERP system. More importantly if you consider the ERP process rather than the software it is evident that the interaction between all functions with a 'single set of numbers' is equally important for an effective service enterprise.

The second and third factor of applying ERP relate to resource planning. Every service company has customers, demands, in-house resources and suppliers, and therefore requires resource planning to deliver an effective customer service. We call this operations resource planning (ORP) as illustrated in Figure 5.4.

Operations resource planning

It is evident from Figure 5.4 that although ORP is not so detailed as MRPII the key steps of the process are similar. From the business plan, a sales and operations plan which covers key products and resources needed to deliver the business plan. The monthly sales and operations planning meeting by senior managers approves the master operations plan. The operations team will review the product portfolio, supplier status and the capacity of own resources, and ensure that purchase orders are raised to procure appropriate resources or services from suppliers. If the capacity of own resources are adequate then an internal control document for the customer order is processed. But a partnership with customers and with suppliers can and will achieve very obvious benefits to

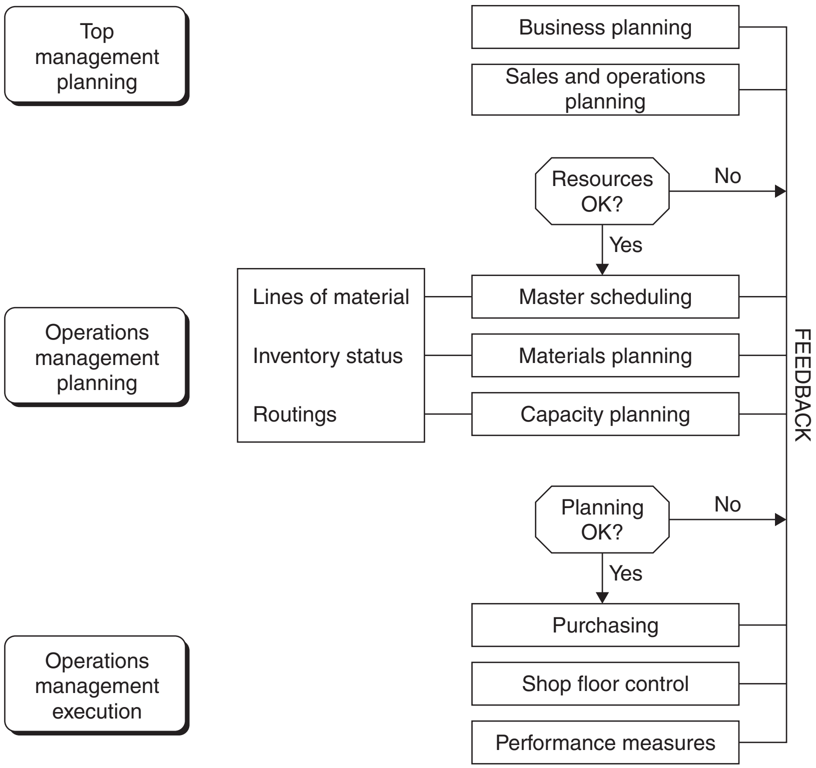

Figure 5.4 Operations resource planning.

all. A partnership with suppliers and a partnership with customers are the beginnings of a radical change in supply chain management. As a result, the service provider, the supplier and the customer achieve benefits in:

- lower operating cost,
- improved service level,
- a greater certainty of a continued relationship.

> *The boundaries between companies will blur as they view themselves as part of an ecosystem, supply chain, or value chain.*
>
> Hasso Platner, Co-founder and Vice Chairman, SAP

Managing capacity

There are two approaches to managing capacity: one is to adjust capacity and the other is to manipulate demand. Generally, organizations will seek to match capacity and demand using both approaches.

Adjusting capacity

The first step is to know what your effective capacity is and what is the constraint that limits the throughput for your operation. The constraint could seemingly be lack of space, lack of handling equipment, lack of people and lack of reliable supply. Once the constraint that limits your capacity to serve your customers is identified then corrective action can be taken. However, what at first might be seen as a constraint might in fact be disguising a lack of planning and vision. For example, lack of space might not be the basic issue. If a warehouse is running out

Table 5.3 Sample self assessment questions

	Poor				Excellent
1. How effective is your master scheduling process to ensure sufficient resource (materials, stocks of finished goods, people) to support the sales plan and expected demand?	0.1	0.2	0.3	0.4	0.5
2. How good is your capacity planning? Do you use a rough-cut capacity plan to develop a detailed capacity requirement plan?	0.1	0.2	0.3	0.4	0.5
3. How well is your purchase scheduling managed? What controls are there in place?	0.1	0.2	0.3	0.4	0.5
4. How well do you pursue a make-to-order policy with an emphasis on material velocity (stock turn)? (Large stocks of RM, work in progress and finished goods = 0.1, just-in-time philosophy with little or no buffer stock = 0.5.)	0.1	0.2	0.3	0.4	0.5
5. How effective are your business processes supported by an ERP system (e.g. SAP R/3)	0.1	0.2	0.3	0.4	0.5
6. How good is your integrated point of sale system?	0.1	0.2	0.3	0.4	0.5
7. How effective is the inclusion of key suppliers in the planning process?	0.1	0.2	0.3	0.4	0.5
8. How effective have you been in the sharing of common coding and database facilitated by Internet or electronic data interchange (EDI) with suppliers and customers?	0.1	0.2	0.3	0.4	0.5

of space to hold materials/finished goods the issue might be overstocking and lack of planning. Indeed all of the possible constraints listed above; lack of space, lack of handling equipment, lack of people, lack of reliable supply could well be eliminated by co-ordinated planning within the organization and by working in closely with suppliers and customers.

Basu and Wright (2005) provide a set of questions which will help to identify where the true constraints are. The questions in Table 5.3 are a sample taken from 200 questions designed to enable an organization to reach world class standards.

Once demand is known or forecast, and once the constraints are identified resources might have to be added or perhaps reduced to meet the expected demand. If demand changes capacity will need to be adjusted to meet the new demand. If there is insufficient capacity, customers must either wait for delivery or if they are not prepared to wait they will be lost. If there is too much capacity, then resources will be under utilized, and stock holding with all the attendant costs of stock holding will increase. For many organizations under utilization of resources and holding of buffer and reserve stock might be considered more profitable than the loss of customers.

Where there is a change in demand the two basic strategies are:

- Strategy 1: Variation or adjustment of capacity
- Strategy 2: Elimination/reduction of the need to adjust capacity

Strategy 1: Variation or adjustment of capacity

This strategy has a short-term approach and a longer-term approach.

In the short-term capacity can to some extent be adjusted. Overtime/double shifts can be worked, unskilled people can be employed to make better use of trained people, people can be re-deployed, jobs or deliveries can be prioritized, and supply and production expedited, subassemblies subcontracted, non-essential maintenance delayed.

In the longer-term facilities, machines and equipment and people can be added. Production can be made in advance and stockpiled. Adding extra people will not immediately add to effective capacity. All organizations rely heavily on people, and a strong corporate culture with the goodwill of people will in the short-term ease the burden of increases in demand. Likewise, the longer people have been with the organization their experience will increase their ability to respond positively. This is referred to as the learning curve. On the other hand, the addition of a new piece of machinery or equipment once it has been set up will immediately add to the effective capacity.

In the above paragraph we have considered adding to capacity in the face of growing demand. But when demand is falling it is often difficult to sell or dispose of capital assets such as buildings, machines, equipment, and vehicles. Generally, disposal of assets will not realize book value. Often an expensive piece of equipment will be valuable when demand is high, but if demand is low might only have scrap value if sold. Thus, when considering adding new capital assets, it is important to understand the effect of demand and product life cycles.

Sadly reducing the number of people is the quickest way of reducing unwanted capacity. Again before new people are added, it is important to be sure that the demand will continue at the current or expected level. Adding new people takes time to recruit and to train, intellectual capital once lost is hard to recover.

Strategy 2: Elimination/reduction of need to adjust

If the objective is never to keep the customer waiting, then it follows that there must always be sufficient amount of all the required resources available at any given time.

It is more likely, however, that it will not always be possible to have sufficient capacity to meet every demand. Therefore, it has to be accepted that there will always be surplus resource in the system, which in a supply chain generally relate to buffer stocks of materials or finished goods, and the holding of reserve stocks. Thus, capacity of every constraining resource will be set at above the expected/forecasted demand level.

On the other hand, if the policy is not to adjust capacity even when demand exceeds capacity it has to be accepted that from time to time customers will have to wait for delivery. The danger is if customers have to wait too long that the organization will get a reputation for poor service and customers will be lost to the system.

Strategy 2, elimination/reduction of the need to adjust capacity has several sub-strategies which we have labelled 2a, 2b, 2bi and 2bii. Also see Wright and Race (2004) and Wild (2002):

- 2a: Surplus capacity of key resources held.
- 2b: Sufficient capacity to meet normal demand, but
  - 2bi: It is accepted that customers might have to wait and it is likely that some customers will be lost.
  - 2bii: Stocks of materials/finished goods are held to meet changes in demand.

Manipulation of demand

With this approach demand is manipulated to match the available capacity. Recognized ways of demand manipulation are advertising campaigns, special promotions, discounts, two for one deals and so on. The travel industry is adept at demand manipulation with high, shoulder and low season fares and tariffs. Where demand exceeds capacity prices are raised, or customers might be allowed or even encouraged to go elsewhere.

If demand is known in advance and is stable, the operations manager's job is to plan and make the best use of resources to meet the demand. In Chapter 2 the bullwhip effect was introduced, Chapter 14 shows how early sharing of information can reduce major and misleading demand fluctuations. Minor fluctuations cause only minor problems. Where demand cannot be accurately predicted then, although the aim has not changed, operations management problems can become extremely complex.

Summary

Resource and capacity management is all about planning. Planning is not possible without information. Resource and capacity planning begins with knowing what our effective capacity is. Effective capacity is the amount of material or product that can be delivered in a given period of time to customers. Having the capacity to meet customer demand requires advanced knowledge of what the demand will be. The chapter began with the need to forecast demand and moved onto planning of resources to meet demand. The chapter concluded with strategies for capacity management and also considered how demand might be manipulated. Chapter 14 deals with sharing of information flowing up through the supply chain beginning at point of sale. Early supply of information allows quicker response to demand fluctuations and reduces the bullwhip effect introduced in Chapter 2.

6

Procurement and supplier focus

Introduction

Procurement and supplier focus is the third building block of supply chain management. Procurement includes:

- Purchasing raw materials and packaging
- Contracting out utilities and maintenance
- Hiring contract or casual labour
- Selecting approved or dedicated suppliers
- Outsourcing
- Use of professional services

The Industrial Marketing and Purchasing Group (IMP) in the 1970s developed a dynamic model of buyer–supplier relationships in industrial markets (the interaction model) and illustrated its applicability through comparative studies of buyer–supplier relationships within and across a number of European countries (France, Germany, Italy, Sweden, UK). The main conclusion of these pan-European studies was that buying and selling in industrial markets could not be understood as a series of discrete and serially independent transactions. Instead, transactions could only be examined as episodes in often long-standing and complex relationships between the buying and selling organization (IMP, 2007).

Procurement or buying is the act of purchasing. Within an organization the purchasing or procurement department is often seen as a less than glamorous department that buys things as cheaply as possible to meet specifications set by more glamorous and important departments such as Marketing and Operations. However, as Porter found purchasing is a key activity in determining the competitive advantage of an organization (Porter, 1985). Lysons and Farrington (2006) rather simplistically say the purchasing process consists of a chain of processes. The chain consists of:

- Receive requisition
- Solicit quotations

- Vendor selection
- Negotiate with suppliers
- Place order
- Receive supplies
- Make payment

Setting specifications, inspection and quality assurance are all included in the overall process.

We contend, as does the IMP Group, that purchasing is more than looking for the right product at the right price and at the right time. We say that a world class company will be aiming to build alliances and long-term relationships with key suppliers. Ideally key suppliers to an organization will be involved in design and development of new product and services. They will be able to provide advice on new technology and methods, they can suggest alternative materials, they will observe and report market trends, and in short they will become an additional source of market intelligence. Gone are the days when we simply placed an order on a supplier and the supplier was not told what or how the product was going to be used. The point being if the supplier knew to what purpose the materials ordered were going to be used that they could well provide suggestions of alternative products and technical advice on how to use, etc. It could be argued that organizations are not purchasing materials but looking for solutions. Lou Gerstner recognized this when he became CEO of IBM in 1993. Up until then IBM developed and built computers. Gerstner came out with a new mission statement that said in effect that IBM would lead the world in the development of information technology (IT) and would provide *solutions* for their customers. Fifteen years on the Mission statement is largely unchanged and reads:

> *At IBM, we strive to lead in the invention, development and manufacture of the industry's most advanced information technologies, including computer systems, software, storage systems and microelectronics.*
>
> *We translate these advanced technologies into value for our customers through our professional solutions, services and consulting businesses worldwide.*

The big change in 1993 being that IBM moved from selling technology to getting alongside customers, understanding their needs and developing a solution customized to the customers' needs. For sales staff of IBM this required a major change in thinking, from selling a box not fully knowing what the customer was going to use it for, to understanding the customers business and to finding a solution to the customers needs. As Gerstner (2002) said this required a major change in culture.

An example of how IBM works to find solutions for customers is given in the following mini case reported by IBM global services (April 2004).

Case example: IBM Global Services

Toyota teams with IBM to drive system performance
To handle significant growth in product volume and variety while maintaining service levels, Toyota looked to IBM Business Consulting Services to help improve its inventory position.

Business need
A process focused organization, Toyota continually seeks to implement key business practices that will help the company enhance performance and customer service at the lowest cost.

Key challenges
Toyota was experiencing significant growth both in product volume and in the variety of products required to meet customers' needs. Company IT staff faced challenges in integrating new components with the interconnected legacy systems to make system improvements. Old code had been edited frequently over the years and was inconsistently documented, and as a result could be deciphered only by selected IT team members. To respond to dealer needs, Toyota required a resilient supply chain management solution to help ensure delivery of the right part to the right dealer at the right time. The solution had to enable Toyota to perform the correct calculations to accurately predict inventory levels for more than 100,000 service parts and more than 1 million part/location combinations.

Solution
IBM Business Consulting Services
Believing that custom development to improve legacy system performance was too expensive and time consuming, Toyota selected software from i2 Technologies. IBM Business Consulting Services provided extensive i2 Technologies implementation experience and skills to develop a state-of-the-art enterprise architecture and infrastructure strategy that included capabilities for performance measurement, data warehousing, demand forecasting, service parts planning and business process and organizational design change.

IBM worked with Toyota associates and i2 to develop an integrated solution that connects Toyota's legacy systems to i2 software to facilitate service parts planning across the Toyota service parts supply chain. Toyota is using i2 Demand Planner for core business forecasting and i2 Service Parts Planner for slow moving spare parts forecasting, inventory optimization and replenishment planning. A data warehouse enables users to access both i2 and legacy system information via drill-down, self-directed activities or a series of reports.

Results

Through improved demand and order forecasting, and better calculation of safety stock requirements, Toyota has reduced over US $46 million in inventory as a result of the implementation. The IBM and i2 solution has enabled the division to eliminate less-critical work, thereby improving efficiency. Better inventory planning also has helped Toyota boost its customer fill rate, limiting rush orders and reducing airfreight expenses.

Thus purchasing is more than simply buying a product. Nonetheless the basic objective of purchasing is to have available the correct materials in manufacture or processing or product in warehousing and retailing when required and to ensure continuity of supply. Thus in true operations management parlance the basic objectives are right thing (meeting specification) at the right time and at the right price.

For key products these objectives can best be met by developing partnerships with suppliers, and for suppliers as shown in the IBM case study to be proactive in forming relationships with customers.

Requisition, vendor selection, negotiation, placing an order

Once a requisition or order has been received by the Purchasing department the customary approach is to check the order or the bill of materials for accuracy and for conformance to the specification and to check records to determine if this is a repeat purchase or a new requirement. For everyday consumables, if it is a repeat buy and there have been no problems in the past (supplier provided product to specification on time and the price is competitive) a repeat order will be placed. If the order is for a new product, or if there were problems in the past which cannot be resolved, then the following steps will be taken:

1. *Possible suppliers will be identified*: Identification of suppliers includes gaining intelligence on their reputation and financial stability. There is no point dealing with an organization that might not be in business in the next few months. Ideally we will be aiming to build up a long-term relationship.
2. *Seek quotations*: Provide to a short list of suppliers, details of specification, quantities and dates. At this stage it might not be wise to be too forthcoming as to the purpose of the purchase. We do not want to be providing too much information in the market place which could help our competitors.
3. *Quotations*: It will be received and a decision made as to who our first preference is.
4. *Negotiations entered into*: At this stage we can provide more detail as to what the product will be used for and seek advice from the supplier. If the product is going to be repeatedly used and ordered and or is an important

item such as a new piece of expensive equipment, and we are seeking a long-term relationship the cementing of a relationship can be more important than a contract written in legalize. *McDonalds claim that with their key suppliers a shake of the hand is more important than a contract*.
5. *Ongoing re-orders*: For fast-moving consumer goods, such as in supermarkets ideally re-orders will be automatically triggered at point of sale, once stock levels drop to a predetermined level. For details of bar coding and point of sale re-ordering systems (e-procurement) (see Chapter 14).
6. *Ordering*: Each order will have an order number. The importance of order numbers are explained in the following section of this chapter.

Receipt, inspection and quality assurance

When goods are received they should be immediately booked into the inventory system and married to the order number. No material or product should ever be issued until it has been booked in. Failure to do so will lead to confusion and inaccuracy in the stock records. In a lean, or just-in-time operation materials are delivered just as required direct into the production line. In a cross docking operation materials will arrive at one side of the warehouse be broken down and sorted into despatch lots for on forwarding. For details of cross docking see Chapter 14. In other operations materials will be received in bulk and stored in warehouses. No matter how received an order has to be booked in and subsequently when despatched or issued must be booked out.

The traditional way of ensuring quality and quantity was to inspect and count goods as received. If suppliers are trusted then only a sample check should be necessary, and in a just-in-time system the test will be as the product goes into production, either a component fits or it doesn't!

Quality inspection and quality control

Quality inspection and control rely on supervision to make sure that no mistakes are made. The most basic approach to quality is inspection on receipt of materials. The next recommended stage is following inwards goods inspection and the detection of problems to work with the supplier in a non-confrontational way investigate and find the causes of problems and to jointly take actions to prevent errors reoccurring.

Quality assurance

Quality assurance includes the setting of standards with documentation and also includes the documentation of the method of checking against the specified standards. Quality assurance can also include a third-party approval from a recognized authority, such as ISO. With quality assurance, inspection and control are still the basic approach, but in addition one would also expect a comprehensive quality manual jointly agreed by the supplier and the purchaser, perhaps including use of statistical process control and the use of sampling techniques for random checking and the overall auditing of quality systems.

Quality inspection, control and assurance are aimed at achieving an agreed consistent level of quality, first by testing and inspection, then by rigid conformance to standards and procedures, and finally by efforts to eliminate causes of errors so that the defined accepted level will be achieved. As Wright (1999) says 'this is a cold and often sterile approach to quality. It implies that once a sufficient level of quality has been achieved, then, apart from maintaining that level which in itself might be hard work, little more need be done'. Where a genuine alliance/partnership has been forged between the buyer and supplier both will continuously be working together to improve the product and the service.

Purchasing ethics, fraud and environmental issues

The golden rule of doing unto others as you would have them do unto you is for most people an easily understood code of ethics. Likewise in the medical profession the easily understood Hippocratic oath was for over 2000 years seen as being sufficient (the modern version which removed references to Greek deities and allowed for abortion was written in 1964). However, in today's changing environment and with conflicting requirements it has been found by many organizations and professional bodies such as lawyers and accountants that a more detailed code is required. Likewise increasingly commercial organizations feel it necessary to have code of ethics and some also have a specific code of ethics for Purchasing Management. The Purchasing Management Association of Canada is an example of a detailed code. It states that:

A. Values

Members will operate and conduct their decisions and actions based on the following values:

1. *Honesty/Integrity*
   Maintaining an unimpeachable standard of integrity in all their business relationships both inside and outside the organizations in which they are employed.
2. *Professionalism*
   Fostering the highest standards of professional competence amongst those for whom they are responsible.
3. *Responsible Management*
   Optimizing the use of resources for which they are responsible so as to provide the maximum benefit to their employers.
4. *Serving the Public Interest*
   Not using their authority of office for personal benefit, rejecting and denouncing any business practice that is improper.
5. *Conformity to the Laws*

In terms of:

(a) The laws of the country in which they practice.
(b) The Institute's or Corporation's Rules and Regulations.
(c) Contractual obligations.

B. Norms of Ethical Behavior

1. To consider first, the interest of one's organization in all transactions and to carry out and believe in its established policies.
2. To be receptive to competent counsel from one's colleagues and be guided by such counsel without impairing the responsibility of one's office.
3. To buy without prejudice, seeking to obtain the maximum value for each dollar of expenditure.
4. To strive for increased knowledge of the materials and processes of manufacture, and to establish practical procedures for the performance of one's responsibilities.
5. To participate in professional development programs so that one's purchasing knowledge and performance are enhanced.
6. To subscribe to and work for honesty in buying and selling and to denounce all forms of improper business practice.
7. To accord a prompt and courteous reception to all who call on a legitimate business mission.
8. To abide by and to encourage others to practice the Professional Code of Ethics of the Purchasing Management Association of Canada and its affiliated Institutes and Corporation.
9. To counsel and assist fellow purchasers in the performance of their duties.
10. To cooperate with all organizations and individuals engaged in activities which enhance the development and standing of purchasing and materials management.

Case example: Purchasing ethics

In the USA in 1980s Jim Locklear was known as a first rate buyer of house ware products in 1987 he joined JC Penny with a significant salary cut. As a buyer Locklear controlled the spending of millions of dollars a year and also sold crucial information, such as the amount of competitors' bids, to suppliers. Over the years he supplemented his salary with as much as $1.5 million in bribes and kickbacks. After a little over a year at JC Penny a cutlery supplier of the firm blew the whistle. However the firm was unable to establish any substantial proof of bribery. Locklear enjoyed the trust of management by dint of his sparkling performance as the sale of tabletop merchandise at JC Penny nearly doubled during Locklear's tenure.

In July 1992 an anonymous letter informed a Penney official of a special relationship between Locklear and Charles Briggs, a Dallas manufacturers' representative, from whom Locklear later admitted to taking $200,000 in bribes. Penney subsequently launched a second investigation and uncovered Locklear's front companies. As a result he was fired by JC Penny and after a trial by Federal authorities he was prosecuted. Locklear faced up to five years in prison and a maximum fine of twice his financial gain.

Adapted from Waller (2002, p. 497)

Rules of Conduct

In applying these rules of conduct, members should follow guidance set out below:

A. *Declaration of Interest*
Any personal interest which may impinge or might reasonably be deemed by others to impinge on a member's impartiality in any matter relevant to his or her duties should be immediately declared to his or her employer.

B. *Confidentiality and Accuracy of Information*
The confidentiality of information received in the course of duty must be respected and should not be used for personal gain; information given in the course of duty should be true and fair and not designed to mislead.

C. *Competition*
While considering the advantages to the member's employer of maintaining a continuing relationship with a supplier, any arrangement which might prevent the effective operation of fair competition should be avoided.

D. *Business Gifts and Hospitality*
To preserve the image and integrity of the member, employer and the profession, business gifts other than items of small intrinsic value should not be accepted. Reasonable hospitality is an accepted courtesy of a business relationship. The frequency and nature of gifts or hospitality accepted should not be allowed whereby the recipient might be or might be deemed by others to have been influenced in making a business decision as a consequence of accepting such hospitality or gifts.

E. *Discrimination and Harassment*
No member shall knowingly participate in acts of discrimination or harassment towards any person that he or she has business relations with.

F. *Environmental Issues*
Members shall recognize their responsibility to environmental issues consistent with their corporate goals or missions.

Purchasing Management Association of Canada (2007)

However, well thought out a code might be it cannot cover every eventuality. For example, under values they say 'Optimizing the use of resources for which they are responsible so as to provide the maximum benefit to their employers'. Their Norms', clauses 1 and 3, reinforces the need to put the employers interests ahead of all else in gaining the maximum value for each dollar. The final section environmental issues could well be in conflict to such an approach. Likewise gaining the maximum value for each dollar, in the short term, might not be in the best interests of building up a long-term relationship with a supplier.

The more detailed a code the easier it will be for a member to find a way around the code to fit a particular set of circumstances. The best any individual can do is to understand the spirit of the code and to do their best to act as they would have others do unto them.

Having said this, sadly not all people are honest, or even if in the past have been honest can still be tempted. Thus there will always be a need for checks and balances.

Fraud

Every organization has to be mindful of the possibility of purchasing fraud. The ingredients of fraud are intent, capability and opportunity. Fraud is not the same as making an error. Errors are mistakes and not intended to happen, fraud is intentional and will include deception. Errors should be found by normal checks and audits. With fraud the perpetrator or perpetrators will do their best to hide what they are doing. Fraud in purchasing often includes collusion. But what is fraud? Does a supplier who offers a free holiday to secure an order commit a fraud? If the holiday is advertised widely, for example an advertisement that says all purchasers of a particular model of a car this month will have a free weekend at a holiday resort is legitimate for the advertiser, but if our purchasing manager takes advantage of this offer when a cheaper car of another make was available would this constitute a fraud? It does not take much thought to see that the purchasing manager was putting his own interest ahead of the company, and has acted unethically however, this would not constitute fraud. Fraud is more devious and is often hard to detect. Much fraud is only detected by outside information including disgruntled junior staff reporting on their managers, or by ex-wives and in many cases discarded mistresses.

Some signs of possible fraud are:

- Employees not taking holidays
- Overstocking, over ordering from one supplier
- Stock shortages at stock take

- Sudden affluence of an employee
- Falling profit margins
- Missing files and documentation

The best protection against fraud is to have a culture of trust and integrity supported by internal and external audits. No code of ethics is going to prevent large-scale fraud. A code of ethics can help people to understand the difference between a business (free) lunch and a bribe.

Environmental purchasing

Environmental purchasing is a most important step in the war against global warning and pollution. Sustainability and accountability for waste and pollution cannot be ignored. At the very least organizations need to be aware of environmental issues and to make their concerns and needs known to their suppliers. This will begin by management establishing a policy, communicating the policy internally, and to their key suppliers. Although the USA has not signed the Kyoto Treaty nonetheless Americans as a whole are very conscious of environmental issues and several State Governments have published environmental purchasing codes. For example, in Minnesota the purchasing ordnance state 'From copy paper to cleaners, automotive fluids to printing services, every product purchased can have an impact on human health and the environment. To reduce the quantity and toxicity of waste in Minnesota, state law requires state agencies and other public entities to purchase recycled, repairable, and durable goods'. Tools and resources are provided to incorporate environmental considerations into standard purchasing practices (2007, www.pca.state.mn.us). For further detail see 'Green supply chain' in Chapter 15.

Make or buy

Make or buy decisions: The fundamental objective of a sourcing strategy is to determine where to make or buy a product or service and why. The sourcing strategies for both manufacturing and service organizations are discussed separately although there are many obvious common features between them. The sourcing strategy goes hand in hand with supply chain management.

Manufacturing

There has been considerable hyperbole regarding world class manufacturing (WCM) and many articles and books have been written on the subject. There have been a number of interpretations of WCM.

Some people associate WCM with working practices influenced by Japan's 'quality movement'. Others understand WCM to be manufacturing at the highest level of performance.

We define WCM as the term applied to organizations who achieve dominance in their segment of the global market and who sustain this dominance against world class competition. Up until about 1990 manufacturing strategy tended to focus on the local area, for example for manufacturers in the UK the concern was the domestic market and the near neighbours of Europe. The emphasis has now moved to the determination of either a global strategy or regional strategy, not only for marketing, but for sourcing.

Sourcing includes materials and labour, and also includes the basic decision of whether to make or buy. The globalization of manufacturing began with sourcing and a search for low labour costs. Manufacturing was transferred from the Western nations and Japan through the establishment of manufacturing facilities in Asia, the Indian Sub-Continent and Latin America. However, it soon transpired that once overseas investment is made in a country the cost of labour creeps up. Additionally as other overseas companies with similar products follow the lead (and move to a country where labour is cheaper) the initial competitive edge of cheap labour gained by the 'pioneer' company becomes a diminished advantage. There have been significant changes in the global market place, demanding a sound sourcing strategy for the manufacturing company as the changes accelerate. These changes include:

Newly industrialized countries (the 'little dragons', now not so little, such as Korea, Taiwan and Malaysia) and the big dragon of the People's Republic of China are acquiring WCM capabilities. Investors wishing to set up manufacturing in these countries will find labour is not as cheap in real terms as it was even 5 years ago. But more importantly these countries are now, without doubt, competitors of world class standing. Other Asian countries which show longer-term potential to achieve WCM in some areas of endeavour include India, Pakistan and Indonesia. Regions which are emerging as WCM contenders include South America and South Africa.

The gradual elimination of tariff barriers and the regional pacts for 'common markets' (e.g. Mercosur, NAFTA, Andina, EU, CER, etc.) are encouraging competition from regionally based groupings of countries. The 'new' markets of what was the East European Communist bloc has provided new opportunities in the global market. Additionally manufacturers in this region are close to achieving the status of WCM.

Improved logistics and electronic communication systems are assisting the implementation of sourcing strategies. The growing similarity of what people want to buy across the world is encouraging global product/process development and marketing. Investment costs for innovation and new technology are becoming too expensive to concentrate in one local market.

A sound sourcing strategy for a manufacturing company will be a requirement for future survival. Catching up with the manufacturing performance of the competitors is not enough. The sourcing strategy of the company must move in step with the corporate strategy and reflect the marketing strategy and innovation programmes of the company. The sourcing strategy should be dynamic in a relentless pursuit of value to customers in a changing market place. As Hamel and Prahalad (1994) accurately forecast 14 years ago, 'the market a company dominates today is likely to change substantially over the next 10 years. There is no such thing as "sustaining" leadership, it must be regenerated again and again'. In order to develop a sourcing strategy for manufacturing it is necessary to have a formal strategic planning process. The process should be flexible and simple to follow and it should be incorporated with other corporate planning processes. Our strategic planning process for sourcing for manufacturing can be found in 'Total Operations Solutions', Basu and Wright (2005) and consists of the eight steps described below:

1. Project brief
   The process is best carried through by setting up a project team of about 10 people and defining the brief of the project. The project team should consist of a project director (e.g. head of manufacturing), manufacturing staff (e.g. industrial engineer, plant engineer, manufacturing manger, quality manager), logistics staff (e.g. planning manager, distribution manager), marketing staff (e.g. brand managers) and commercial staff (e.g. accountant, purchasing management and human resources staff).
   When preparing the project brief it is useful to have those documents that cover current company activities such as capital investment, annual operating plans and long-term plans. In addition, any other relevant reports (such as information on competition, market place, economy and government regulations) of the countries covering the scope of the strategy will help with this activity. The project brief should clearly state the scope, time scale, deliverables and resources required for the project.
2. Operational mission and objectives
   The manufacturing mission defines the aim of manufacturing in the corporate strategy or the business plan. The mission statement must fit the capabilities of the manufacturing function. Unless the mission is feasible it will be no more than mere words or rhetoric. Usually the mission statement is described in broad terms as illustrated by the following example:

   The manufacturing mission is to achieve the lowest unit manufacturing cost relative to competition without sacrificing high standards of quality, service and flexibility to the customer.

This mission statement has a priority on low cost. Alternative priorities could include one or more of: quality, customer service, rapid introduction of product, visible presence in emerging markets, combating a dominant competitor, etc. The point to note is that the mission has to be sufficiently specific for a clear objective or objectives to be readily distinguished.

Manufacturing objectives consist of performance measures that the company's manufacturing must achieve as part of the annual operating plan. Achievement of the objectives will result in the achievement of the mission.

3. Strategic factors
   The understanding and analysis of strategic factors can determine the success of a sourcing strategy. Strategic factors relate to the longer-term

implication of both the external and internal factors to project manufacturing into the future. These factors are competition, customer preferences, technology, environment, economic conditions and statutory regulations. To develop a sourcing strategy for manufacturing, so as to gain a competitive advantage, a detailed competitive position analysis will be necessary. This analysis determines how the strengths and weaknesses of the company's manufacturing position relate to major competitors (both current and potential competitors). The dimensions for this analysis can be cost, quality, dependability, flexibility and innovation. Following this analysis the company should be able to identify any gaps in manufacturing competence and establish priorities for a future strategy so as to gain a competitive advantage. It is critical to determine what should be made and whether to make or buy. Such decisions depend on the long-term volumes of the product and of the level of technology required. To identify the preliminary grouping of the sourcing of products. The project brief may be reviewed and restated after the analysis of all strategic factors.

4. Data collection and data analysis

   Once the revised project brief has been finalized, the next stage is the collection of data and the analysis of data. Although the need for data will vary, the following areas will need to be considered:

- General information
  - Internal information of the company regarding annual plans, long-term plans, R&D and marketing.
  - External information regarding competition, economic and political factors of countries involved, social and cultural aspects and environmental (green) issues.
- Product information
  - future, 10-year sales forecast by products
  - past, 5-year sales history
- Plant information
  - present capacity of own plants
  - investment plan to increase capacity
  - present levels of efficiency
  - other manufacturing alliances (e.g. subcontractor capabilities)
- Stock information
  - stock policy of materials and finished products
  - warehousing area (space and capacity) and method of storage
  - method of distribution to customers
- Personnel information
  - projection of people availability and skills
  - industrial relations of manufacturing sites
  - amenities required
- Cost information
  - manufacturing costs of products by site
  - distribution cost elements

– cost of warehouse building per square metre
– cost of office building per square metre
– cost of an employee per year (total cost, i.e. wages, benefits and training).

The purpose of this stage is to calculate the capacity of plant and services for the projected volume and estimate the space required for each activity for each manufacturing site. It is normally sufficient to carry out these analyses for the current year, and at the mid-stage and at the completion of the plan or when a significant event (e.g. the manufacture of a new product) occurs. The utilization of assets as determined at this stage should help to establish what to manufacture and where, and the profitability of each site.

5. Strategic options
   Strategic options determine how sourcing or own manufacture is going to meet the objectives of the mission. It is useful to reiterate that the objectives refer to performance measures (such as cost, flexibility, quality, etc.) and strategy refers to how these objectives will be achieved. Strategic options are normally expressed in a number of sourcing scenarios. These are derived from the understanding of the competitive strengths and weakness from the foregoing stages. As a general rule there should not be more than eight scenarios. Eight scenarios are manageable and enable adequate attention to be given to each scenario. A critical analysis of each scenario is then carried out against the criteria of manufacturing objectives and strategic factors. Two or three scenarios are then short listed for quantitative evaluation.
6. Options evaluation
   The aim of this stage is to evaluate two or three main options in order to select the best strategy for the future. The analysis should take advantage of simulation modelling tools to select a strategy by optimizing the total operating cost. Costs only need broad estimates for the evaluation of options.
   The strategy should then be further tested by comparing the investment costs of alternative development plans with quantitative tools such as discounted cash flow (DCF) analysis.
7. Implementation plan
   The success of a sourcing strategy for manufacturing will depend on how effectively the changes have been implemented. There should be a structured implementation plan describing the phasing, responsibility, costs and obstacles that have to be overcome.
   The strategy itself should not have major changes every year or there will be little chance of maintaining the strategic goal. Tactics should be continually adjusted to meet changing circumstances.
8. Review
   As stated above, there is a need for regular evaluation and review of progress to implement the strategy. In addition to the regular review the entire strategy should be formally reviewed on an annual basis.

Service sector

In the service sector the sourcing strategy buzzwords such as 'outsourcing', 'off-shoring' and 'in-sourcing' have gained currency. Outsourcing is the collaboration with a partner to manage a part of your business. An example is IBM supplying and managing on-site the information and technology function for Toyota. There are distinct categories of outsourcing in the service sector:

- IT outsourcing (e.g. programming)
- Business process outsourcing (e.g. handling all administration)
- Managed services (e.g. call centres)

Background of outsourcing

A well documented example of business process outsourcing, albeit in manufacturing, is provided by the Coca-Cola Corporation. For over 100 years Coca-Cola has been producing syrup and marketing bottled products. The actual production and bottling of the product (to Coca-Cola's strict standards) is done locally by its global network of business partners. A huge explosion of outsourcing can be attributed to the concept of 'core competence' popularized by Hamel and Prahalad (1994). The principle is fundamentally simple. For example, by analysing and understanding Porter's value chain (1985) an organization can focus on the elements that are core to its business and outsource others while maintaining strategic control. The examples of successful outsourcing companies include Dell and CISCO. Dell Computers Company has focused on its key activity as sales and outsourced non-core functions such as logistics and maintenance. CISCO has identified design and network solutions as its core activity and outsourced the manufacturing of infrastructure components.

Rationale of outsourcing

A particular advantage of outsourcing is cash flow, flexibility and releasing key management resources, but other benefits include external expertise and cost savings. There are several external factors driving the growth of outsourcing:

- The rapid change in the technology landscape, especially in information and communication technology (ICT); external vendors are often in a position to provide more effective solutions support in the new technology.
- Globalization is a strong catalyst in outsourcing by enhancing the transparency in financial reporting, wider choice of suppliers and more competition.

Outsourcers offering service level guarantees have a powerful proposition.

Basu's outsourcing matrix.

Basu's model (2004, p. 270) as shown in Figure 6.1 provides a useful framework in make or but decisions. The model shown below uses the core strength (technology and/or patent life) as the x-axis and product volume as the y-axis. Sourcing strategy is determined according to the location of products on the grid:

1. *High technology/high volume*: These products are suitable for own manufacturing. It will be appropriate to invest to retain the core strength.
2. *High technology/low volume*: When the volume is low the preferred strategy is to 'in-source'. This means that either the global manufacture of product is centralized at a single site, or the capacity of high technology are utilized by gaining orders from outside companies.
3. *Low technology/high volume*: After a period the technological advantage of a product reduces and it becomes a mere commodity. If the volume is high then a supply partnership can be considered with a dedicated third-party supplier.
4. *Low technology/low volume*: If demand is low and there are more than one supplier available long-term supplier agreements/partnerships are not important.

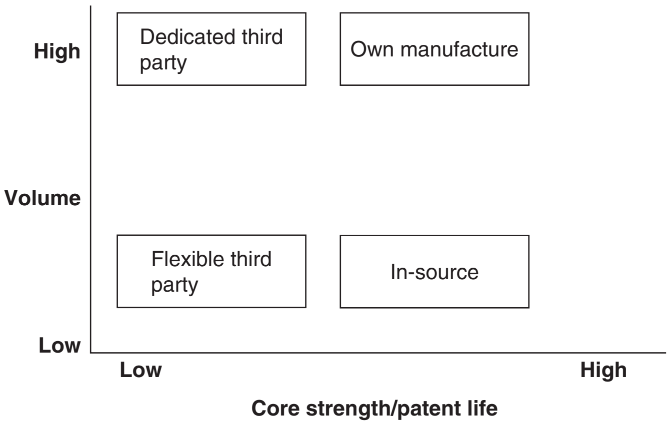

Figure 6.1 Basu's outsourcing model.

Off-shoring

Off-shoring is a form of outsourced managed services where skilled labour is cheaper. Cost savings are primary benefits. Other benefits include time zone differences enabling 24 hour services and access to more willing well-qualified workers to tackle boring jobs. An example is call centres located in India serving callers (customers) in England. There are some risks of off-shoring. These include:

- Services going down because of telecommunication problem and inadequate training.
- Data and physical security are in potential danger.
- Excessive foreign travel.

The ways to minimize these risks include minimizing foreign travel, keeping your software code and using a third-party broker.

In-sourcing

In-sourcing means centralizing multiple, distributed operations into a semi-autonomous unit. This is managed separately and accountable to the business, like an outsourcer, but remains under the organization's control.

The advantages of in-sourcing include:

- The business maintains strategic control.
- It avoids third-party margins.
- It is reversible.

Service level agreements and joint service partnerships

In a service level agreement (SLA) all three words carry equal importance. The document should define what services are to be delivered and the levels of performance expected. It is also an agreement between the customer and the supplier and not a unilateral declaration. For simple functions like catering fixed price contracts by SLAs are easy to implement. However, they are highly limiting and inappropriate for strategic partnerships. The agreements (also known as joint service partnerships) should include:

- Shared gains or structured incentives based on added value beyond core services.
- Shared risks.
- Best practices, training and cost-effectiveness initiatives are freely shared.
- Forecast data and planning processes are shared.

e-Procurement

The influence of the Internet in the supply chain and electronic transfer of information and funds is detailed in Chapter 12 and also in Chapter 14 the 'Retail' chapter.

The key aspect is that the Internet enables systems to communicate across organizational boundaries. The various e-procurement models are:

- *EDI networks*: Providing communication between a few trading partners (buyers and sellers).
- *B2E*: Allowing transfer of information within an organization between departments and employees. For example, templates of documents, automated approvals for routine requisitions and standardization of procedures.
- *B2B*: A website sometimes where business 'meet' to buy and sell. A closed exchange is open only to members. An example is Compuware's Covisint exchange for automotive and healthcare industries, see www.Covisint.com/about (2007).

A public exchange sometimes referred to as a portal allows almost anyone to enter and to trade on-line.

- *B2C*: An e-mail address or web page that allows customers to buy on line (e.g. airline bookings and e-tickets).

Other expressions used in e-procurement are e-catalogues, e-auctions and reverse auctions.

- *e-Catalogues*: These provide on line and up to date lists, photographs, sometimes video clips of products, specifications, price, etc. Amazon is a good example (see www.amazon.com).
- *e-Auctions*: Here a seller can display a product on-line and buyers can make bids until a price is reached and a sale agreed. The bids might be public or sealed. With sealed bids the various buyers are in fact tendering as they cannot see what the other bids are.
- *Reverse auctions*: Here the buyer advises the product and quantity they want, and suppliers complete on line by offering lower prices. In a reverse auction it would not be regarded as ethical for the buyer to lodge proxy bids.

Summary

In this chapter, we began with a discussion as to why procurement and a supplier focus is an important building block of supply chain management. The advantages of developing long-term relationships with key suppliers were explained. It was shown that cost is only one aspect. When selecting suppliers, reliability, delivering to specification on time and to the right quantity in short reliability and stability are key issues. The advantages of outsourcing and issues to consider when deciding whether to make or buy were also explained. Other issues covered were ethics, fraud and e-procurement.

7

Inventory management

Introduction

Stocks of materials (inventories) are kept as a buffer against variations in demand and to overcome uncertain supply. This buffer can be regarded as safety stock. Inventory is held along the supply chain in various warehouses, factories (work in process) and retail store shelves. These inventories can cost from a minimum of 15 per cent up to 40 per cent of their value per year (storage space, handling costs, energy costs including heating and refrigeration, stock slippage and insurance). Therefore, careful management of stock levels makes good business sense.

Location of inventory

As explained in Chapter 3, inventories usually reside in three stages of a process, viz. input stocks (e.g. raw and packaging materials), in process stocks (e.g. semi-finished products) and output stocks (e.g. finished products). Within each stage there can be a number of stock locations, each holding a base stock. The 'base' stock is the amount of inventory essential to meet normal or planned demand. Also at each location it is likely that there will be buffers of safety stock. Buffer stock is held to meet the above average demand and to overcome uncertain delivery lead times. The more stock locations the greater will be the amount of stock held. Consider a supply chain that has one factory, two warehouses, three distributors each holding base stock and buffer stock and compare to a situation where the factory distributes direct to retailers. It does not take much imagination to see that the greater number of stages in the supply chain, the greater amount of base and buffer stock will be held. The ramifications of number and location of distribution points and warehouses is considered more fully in Chapter 9.

Holding cost

Inventories can accumulate as a result of poor planning and scheduling or by design. Generally, inventory is viewed as a negative impact on business as it incurs costs of capital (interest paid or interest fore gone), storage space, handling, insurance, increased risk of damage and theft, and obsolescence.

Risk costs

- fashion changes (style, colour and texture),
- past 'use-by-date' for foods,
- deterioration,
- obsolescence due to new technology or to model changes which make 'old' models out of date,
- damage,
- pilfering/theft.

Storage costs

- buildings,
- racking,
- special storage such as refrigeration or secure storage of dangerous goods,
- handling costs (specialised equipment, wages, etc.).

Finance costs

- Interest on money invested in stocks of materials, either the organization has had to borrow money to pay for the stock held or the money 'invested' in the stock could have been used elsewhere in the organization.
- Insurance.

Most of the above require no explanation, it is readily apparent that old stock whether it is old technology or simply no longer fashionable is hard to sell, and in some cases scrap value will not even cover the original cost. On the other hand, lack of inventory leads to lost production in the factory and lost sales at the end of the supply chain. Holding inventory of materials and finished products therefore can be seen as an insurance against uncertainty of supply and to overcome unforeseen variations in demand.

Inventory management is a good indicator of the effectiveness of supply chain management. It is relatively easy to achieve higher levels of customer service by accumulating excessive stocks. It will also obscure short-term operational problems. But this is a costly and risky option in terms of cash flow. Obsolete inventory, be it for changes in technology, fashion, or in foodstuffs past the use-by-date has little salvage value. It is vital to optimize the inventory level.

Consumed and non-consumed inventory

Wild (2002) introduced the concept of consumed and non-consumed stocks. Consumed items (e.g. materials or products) are used by the process or customers and must be replenished in shorter cycles. Non-consumed items (e.g. capital equipment and labour) are repeatedly used by the process needing repair and maintenance and are replaced in longer intervals. This chapter considers inventory of stocks to be consumed at the next level of production or inventory held to meet the demand of (i.e. supplied to) the next stage of the supply chain. Wild refers to this as a single stage inventory.

In service industries operations managers might have a nonchalant attitude towards inventories, but not so the accountants. Differences between services and physical goods are addressed both from operations and marketing. Among the differences identified within marketing and operations, literature are intangibility, heterogeneity, inseparability and perishability (Grönroos, 2000). It is perceived that services are one-off and cannot be stored. There are of course consumed stocks (e.g. stationery, brochures, catalogues, etc.) in service industries which require inventory management. However, in the service sector more emphasis should be focused on managing non-consumed stock (viz. database and skilled people).

Inventory management tools

In traditional inventory management there are two basic approaches: the pull approach and the push approach. In a pull system as shown in Figure 7.1, a warehouse is viewed as independent of the supply chain and inventory is replenished with order sizes based on a predetermined stock level for each warehouse. The stock management model for the pull system is normally geared to establish re-order level (ROL) and re-order quantity (ROQ).

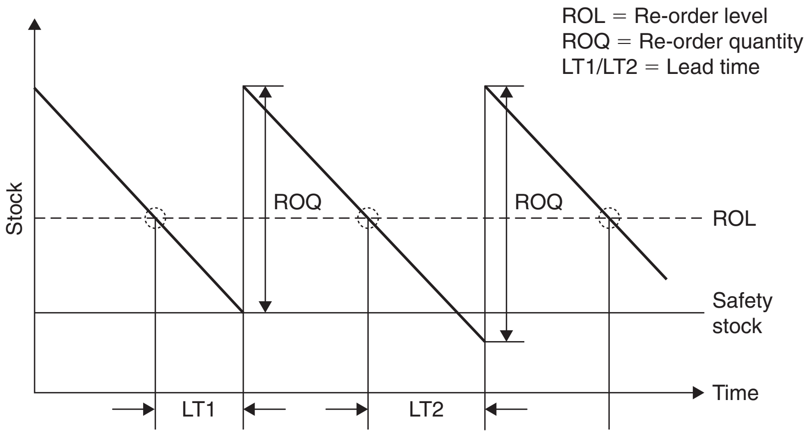

Figure 7.1 A basic ROL/ROQ model for a 'pull' system.

That is, when the stock drops to a certain level, a re-order is triggered of a predetermined amount. The ROQ takes into account past demands and the lead times for a re-order to be satisfied. The aim is to have as small amount of inventory as possible on hand at any one time, and the ROQ should likewise be as small as possible. However, in some processes, such as a batch system, there will be a minimum amount that can be produced and in other cases there can be economies of scale which will determine the optimal size of an order. The push method is used when economies of scale in procurement outweigh the benefits of minimum inventory levels as achieved in the pull method (see Figure 7.2).

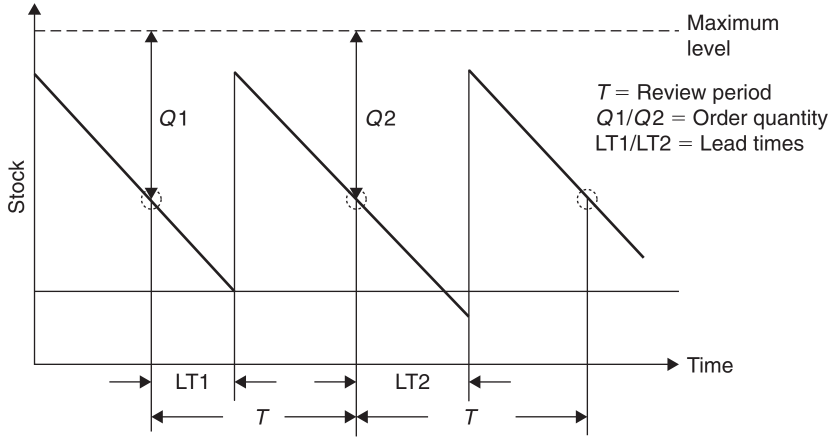

Figure 7.2 A basic fixed interval model for a 'push' system.

That is, the warehouse does not decide the quantity of the order, but will receive a delivery as determined by the production schedule. Normally a fixed interval review model with a forecast demand for manufacturing planning is used in a push system.

With the support of information technology, businesses are moving towards a virtual inventory system with a single stock concept which can be held anywhere in the system, be it on order with the supplier, in production or at the point of sale (POS). This is the concept of virtual inventory management (VIM) or electronic inventory. Thus, instead of considering stocks of raw materials, work in progress at the various stages of production and finished goods in warehouses as separate stocks of inventory, purely because of their physical location, inventory is now considered as being part of one single stock.

Economic order quantities

The economic order quantities (EOQ) system is a push system that can be used when there is an advantage in buying in bulk rather than making several small purchases. The EOQ system calculates re-order amount using a formula known as EOQ – Economic Order Quantity. The EOQ assumes that:

- Demand is constant and known.
- Deliveries are to specification, the right quantity and on time.

- There is no slippage of stock due to theft or damage. This means that what the computer shows as being in stock is correct.

The formula for EOQ is

$$Q = \text{The square root of } 2 \times DO/PH$$

where Q is the EOQ, D is the annual demand (in units), O is the cost of raising an order, P is the price per unit and H is the holding cost.

Example: Economic order quantity

Demand	60,000 units per annum
Order cost	£100 per order raised
Price per unit	£75
Holding cost	12% per annum

Thus, $2 \times 60{,}000 \times 100 = 12{,}000{,}000$
Divided by $75 \times 0.12 = 9$
$12{,}000{,}000/9 = 13{,}333{,}333$
Square root of 13,333,333 is 3651

However the supplier might only deliver in packages of 100, thus each order would be for 3600 rather than 3651 or may be 3700. As the total demand is 60,000 per year if each order is 3600 there will be 16 or 17 orders per year.

Cost of ordering

Cost of ordering might not seem to be a big cost (order form, an envelope and a stamp). However, consider the savings made when the British Stock Exchange implemented an electronic share transfer system in the mid-1990s. Prior to this share transfer cost 30 pounds per transaction, once share transfers were on-line or 'paperless' the cost was reduced to 30 pence per transfer. Many organizations have made savings of a similar magnitude by adopting an on-line purchasing system. For example, in the supermarket bar coding at the checkout can trigger an automatic on-line re-order when stock of a particular item drops to a preset level. This will save on staff numbers which would in a manual system be required to physically count stock, calculate forecasted usage, and raise order forms, etc.

Calculation of safety stock

Safety stock is the buffer inventory to cover the variation of demand and supply during lead lime. There are many uncertainties of demand and supply, for example, customers may increase an order, machinery might break down, or supplier might be unable to deliver on time due to transport problems.

There are key parameters affecting the calculation safety stock:

- forecast accuracy
- lead time
- expected service level

Example: Re-order level with safety stock

Consider a given data for a garden centre selling sacks of fertilizer:

– Average demand	10 sacks per day
– Service level required	95 per cent
– Lead time	15 days
– Standard deviation of daily demand	3 (for a normal distribution)

Determine safety stock and re-order level

For 95 per cent service level safety stock $= 1.64 \times$ standard deviation of demand during lead time

Standard deviation of demand during lead time

$=$ Square root of (15×3^2)

$= 11.6$

Safety stock $= 1.64 \times 11.6 = 19$

Reorder level $=$ Average demand during lead time $+$ safety stock

$= 10 \times 15 + 19 = 169$ sacks

Adapted from Wild (2002, p. 600)

EOQ and lean production

It might be considered that the lean or just-in-time approach where items are purchased to arrive just when required is not compatible with the bulk ordering approach of EOQ system. It is true that EOQ is not applicable for ordering most components in a just-in-time system. None the less some items will be consumed in such quantities that buying one item at a time would not be sensible, that is the purchase of 1 meter of cable when several dozen metres are used daily.

Vendor-managed inventory

The use of a third party (3PL) to take over some, or all, of a company's logistics responsibilities is becoming more prevalent. 3PL is simply the use of an outside company to perform all or part of the firm's materials management and product distribution function. 3PL relationships are typically more complex than traditional logistics supplier relationships. Modern 3PL arrangements involve long-term commitments and often multiple functions or process management. As organizations focus on their core competencies they are looking for other specialist organizations to partner with.

As customer satisfaction becomes more imperative and margins get tighter it makes sense to create cooperative efforts between suppliers and retailers in order to leverage the knowledge of both parties. The types of retailer–supplier partnerships can be viewed on a continuum. At one end is information sharing. At the other is a consignment scheme of vendor-managed inventory (VMI), where the vendor completely manages and owns the inventory until the retailer sells it. In a simple quick response strategy, suppliers receive POS data from retailers and use this information to synchronize their production and inventory activities with actual sales at the retailers. In this strategy the retailer still prepares individual orders, but the POS data is used by the supplier to improve delivery performance and hence reduce supply variability. In a continuous replenishment strategy, sometimes called rapid replenishment, vendors receive POS data and use this data to prepare shipments at previously agreed upon intervals to maintain specific levels of inventory.

With a VMI system, the supplier decides on the appropriate inventory levels of each product and the appropriate policies to maintain these levels. The goal of many VMI programmes is to eliminate the need for the retailer to oversee specific orders for replenishment. The ultimate is for the supplier to manage the inventory and only receive payment for it once it has been sold by the retailer; in essence the retailer is providing an outlet for the supplier!

Distributor integration (DI)

Modern information technology has enabled this strategy in which distributors are integrated so that expertise and inventory located at one distributor is available to the others. DI can be used to address both inventory-related and service-related issues. In terms of inventory, DI can be used to create a large pool of inventory across the entire distributor network thus lowering total inventory costs while raising customer service levels. Similarly, DI can be used to meet the customer's specific needs by directing those requests to the distributor best suited to address them.

Balance date/stock-takes, or 'Where did the stock go?'

Wright and Race (2004, p. 199) from bitter experience consider the problems that occur when physical stock takes reveal that the computer records are incorrect:

> *The only true way of knowing what is really on hand is to physically count it. The problem at balance date is that when the auditors count the stock and*

compare it to stock records generally there will be a discrepancy. Stock discrepancies only occur for a limited number of reasons:

1. *The stock was never received (short deliveries or over-invoiced).*
2. *The stock was sold but the sale was not recorded.*
3. *Stock has been stolen.*
4. *Stock has been damaged or disposed of but disposal has not been recorded.*
5. *Stock has been miscoded on receipt or when sold (e.g. 200 hoses booked in, but actually 200 hose-clips received).*
6. *The stock was sold before it was booked in.*
7. *Stock has been 'borrowed' (in the sale representative's van for display/demonstration purposes).*

The generally accepted methods to maintaining the integrity of stock records is:

1. *Stock orders entered into the computer system.*
2. *Stock booked into the system when received. The system will compare and verify that what was ordered is the same as what is received*
3. *The system will not allow stock to be sold before it is booked in.*
4. *Sales must be entered through the system.*
5. *The system triggers payment advices. Payment is not triggered by suppliers' invoices. In this manner you will only pay for what you ordered and actually received.*
6. *It is advisable to have weekly, fortnightly or monthly rolling stock-takes on a portion of the inventory. 'This should overcome the drama of an annual stock-take, and should also reduce your audit account' (Wright and Race, 2004).*

The above system relies on a standard computerized system.

With an integrated supply chain approach a heavy reliance is placed on the information technology system. Thus, if goods are bar coded as they pass over the sensor at POS, the customer's statement is updated, a delivery docket and invoice raised, stock records of the retailer are updated, sales figures and margins calculated and recorded, and a re-order is triggered. If suppliers are tied into the system then the supplier will also be automatically notified of a replacement re-order.

Activity-based costing analysis

Activity-based costing (ABC) analysis is an adaptation of Pareto analysis. Wilfredo Pareto was a 19th century economist who determined that 80 per cent of the wealth was held by 20 per cent of the population. This axiom can be adapted to most circumstances, for example 80 per cent of car accidents are caused by 20 per cent of the drivers (young men between the ages of 17 and 25).

In inventory management using the Pareto approach, the assumption is that 20 per cent of the items held will account for 80 per cent of the value of materials on hand. A further refinement is ABC analysis. Using the ABC approach inventory will be categorised as high value, medium value and low value. The high value "A" items will require the greatest control, the "B" items will require lesser attention, and the low value "C" items (nuts and bolts) will require minimal control. A breakdown of ABC items might look something like that shown in Table 7.1.

Table 7.1 ABC analysis of inventory

	"A" class items (%)	"B" class items (%)	"C" class items (%)
Number held	11	29	60
Value	54	41	5

ABC analysis facilitates cyclical rolling stock takes whereby a series of 'mini' stock-takes are made during the year. For example all "A" class items might be counted weekly, and a percentage "B" items might also be counted on a weekly basis.

Performance measures

Chapter 19 is our measurement chapter, but as each chapter is designed to stand alone inventory measurements are discussed here. Performance measures are needed to drive continuous improvement, if we do not know how well we are performing, if we do not have measurements, how can we know if we have improved, in terms of client satisfaction, stock outs and stock turns. Measurement is also necessary to set directions and targets for the future. The criteria for performance measures should cover a balanced approach to all key parameters of the supply chain and should provide operational measures rather than purely financial measures. Measures should be simple, easy to define and easy to monitor. In determining what should be measured it is useful to get away from standard accounting measures. Supply chain management requirements are different from those of the accountants. In determining our own measurements we should ask:

- What should be measured and why?
- What is the benefit of this measure, how does it help us to achieve our goal?

Once we decide what should be measured, then we can determine how it should be measured. Measurements are of any use only if they are fed down to the workers and if the workers understand what the measurements mean. Ideally if a worker receives a measurement, then that worker should be encouraged to become involved in finding ways to improve the system so as to achieve improved results. Measurements should never be used as a means of levelling blame to one department or to criticize any one individual. Measurements should be aimed at finding where problems occur so that action can be taken so as to prevent future mistakes. After all, no one section or department works alone; we are all in this together. If the company goes down we all go down!

Without upsetting the accountants we believe that no measurement is sacrosanct and each measurement should be challenged. A measurement that does not help to improve the system is an unnecessary cost. Figure 7.3 shows basic measurements needed in inventory management.

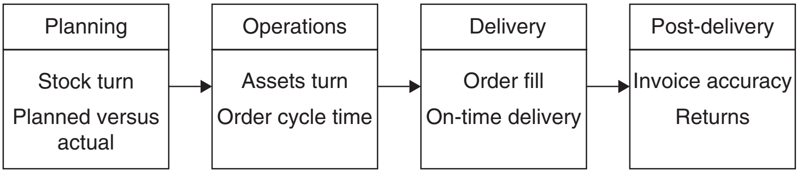

Figure 7.3 Inventory measurements.

Stock turn

'Stock turn' is the ratio of the total sales (or throughput of a product) and the actual stock at any time, both being expressed in either money or volume. The objective is not only to maximize the stock turn (i.e. minimize average stock level), but also to maintain stock availability. Stock availability (the percentage of demand that can be met from available stock) is another measure of performance; availability can also be measured by the number or percentage of orders satisfied within a given target time frame.

The unit of stock turn is a number or ratio. It is also a common practice to express stock profile in terms of equivalent weeks or days of stock. For example, if the cost of goods sold (raw materials plus direct labour and other manufacturing costs but not overheads) is £25,000 and the amount of stock of finished goods on hand totals £5000, then the number of days of finished goods equals 73 days ($5000/25{,}000 \times 365 = 73$). That is, on past performance it is going to take just two and half months to sell all the finished goods we have on hand. Assuming that we have already paid the suppliers and have paid our workers' wages and paid the other costs of production, this obviously means that our inventory of finished goods is putting pressure on our cash flow. The same types of calculations can be made for stocks of raw materials and work in progress.

One company we visited was proud of the fact that in their high street stores they only ever had 7 days of retail stock (own product) on hand. Their re-order system to their central warehouse was on-line and re-orders were delivered within 24 hours. The warehouse of finished goods held 6 months' stock, and the stockpile of raw materials for production amounted to 7 months' supply.

Assuming suppliers were paid within 1 month of supply, this meant that this company was waiting 13 months and 7 days to recover the cost out-laid for stock! Not really anything to be proud of when looked at in this fashion.

The share of stock by primary materials (i.e. raw materials and packaging materials), work in progress and finished products varies according to the products and method of manufacturing as illustrated in Figure 7.4.

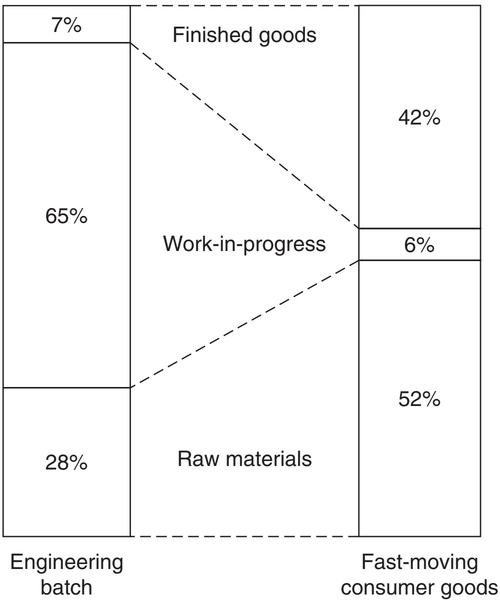

Figure 7.4 Stock profile: percentage of total stock.

'Planned versus actual' (also known as planning efficiency) is a simple measure of whether the plan is being achieved. This measure can be for any period, that is this month we planned to produce 80,000 units, but our actual production was 70,000 units. Therefore, we were 87.5 per cent efficient. This measure is of little use if we cannot trace back to why production was short of the plan, not with a view to criticize but with a view of correcting the system so that we will be more efficient in future. It is more meaningful when planning efficiency is expressed for each product or stock keeping unit (SKU) rather than for total volume. Sometimes this measurement will be more hard-hitting if it is expressed in lost sales.

Planned versus actual

Figure 7.5 shows a 'Pipeline map' of an fast-moving consumer goods (FMCGs) product. It is a common practice to express both the planned and actual production

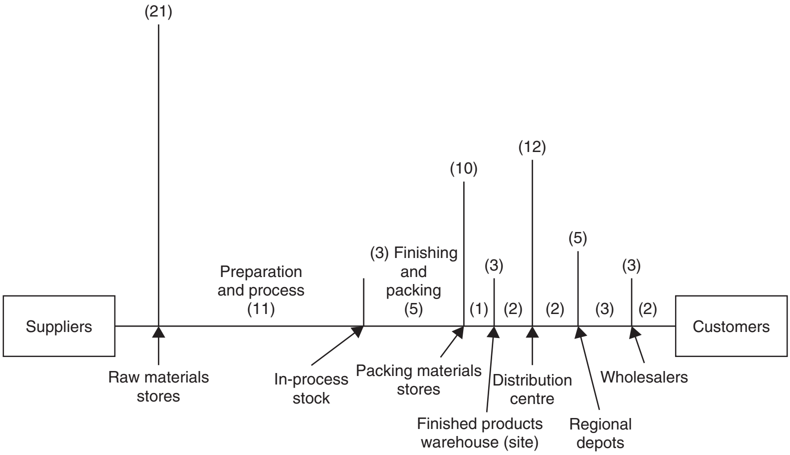

Figure 7.5 Pipeline map of an FMCG product.

of each week in graphs and calculate planning efficiency figures for the week and cumulative year-to-date. But all this effort is only of any use if the information, however expressed, leads to corrective action being taken. Too many measures too often will only serve to confuse the real issues. Scott and Westbrook (1991) introduced the concept of a pipeline map, to present a snapshot of the total stock in a supply chain. In Figure 7.5 the supply chain of an FMCG product is mapped by a series of horizontal lines representing the average time spent in major processes between stock-holding points, and a series of vertical lines showing in the same scale (e.g. days), the average stock cover at each point. Pipeline volume is the sum of both the horizontal and vertical lines and represents the time needed to ‘flush’ the inventory in the supply chain at an average rate of throughput.

Pipeline mapping is a useful tool to understand the planning performance of a supply chain, in particular inventory management, but additional analytical techniques should be used to identify the key areas of improvement.

Cycle times

‘Asset turn’ is the ratio of total sales and fixed assets. It is important that the value of fixed assets is updated by taking into account the depreciation rate for the type of asset according to a defined accounting policy of the company. Assets utilization (time-based) is more relevant to all manufacturing performance. However, the measure of assets turn (value-based) provides an indication of investment in the supply chain. In the short to medium term this measurement is of little use as the investment in the assets has already been made and the measurement is against a past decision. In biblical terms the sins of the fathers are being visited on the next generation.

'Order cycle time' (also known as lead time) is the elapsed time from the placement of an order by the customer to the receiving of delivery (see Figure 7.6). It is important to state standards to suit customer requirements and analyse the total cycle time into relevant components. Lynch and Cross (1991) claim that only 5 per cent of cycle time is devoted to adding value. In many cases the product is waiting to be worked on 95 per cent of the time. (This excludes raw materials in stock and finished goods in the warehouse.)

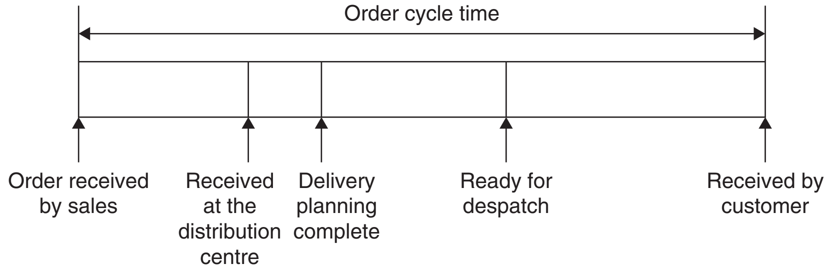

Figure 7.6 Cycle lead times.

'Order fill' is the percentage of first time satisfied orders. From the customer's point of view this is probably the most important measurement. The order is the correct quantity and quality. The next most important measure as far as the customer is concerned is if the delivery is on time! 'On time delivery' can be expressed as a percentage of full orders delivered on time. 'On time' may be determined by the standards of order cycle time set for a customer or the agreed date of delivery as set by the customer.

Summary

This chapter has considered the importance of having sufficient stock on hand so as not to delay production or to keep the customer waiting longer that is acceptable. However, holding stock is a cost. A balance has to be found between achieving the objective of customer satisfaction and the objective of a reasonable return on assets employed. Stocks of inventory are a major asset in manufacturing and retailing and in the intermediate stages of distributing and warehousing. This chapter has covered several approaches to inventory management within the supply chain.

8

Operations management in the supply chain

Within an organization operations management is the function which interacts with and delivers products and services to customers. Operations management is not limited to the manufacture of products. Everyone, no matter what their role, is an operations manager. We all use resources, and we all have a mission to employ these resources as efficiently as possible for the benefit of the organization for which we work. 'Efficient operations management is crucial to the success of any organization. The role of an operations manager is to provide customer service within the framework of the organizations policy and to use the resources as efficiently as possible. Simply put: the operations manager makes things happen' (Wright and Race, 2004, p. 4). For supply chain management operations management is where, with in factories and facilities, plans are converted into reality to produce goods and services. Input resources basically consist of information, materials and utilities. They are transformed into desired outputs by the three converting components of people, process and technology. In addition to the conversion of inputs into outputs operations management is responsible for the physical flow of the supply chain. This includes the upstream flow of input resources and the downstream flow (distribution) of outputs.

The input–process–output model shown in Figure 8.1 is the cornerstone of operations management and can be found in most operations management texts. The modern approach to operations management is to consider operations as a process and a whole systems approach is taken.

Input => Process => Output

Figure 8.1 The IPO model.

Service operations

The distinguishing features of service operations are that the service cannot be provided without customer input and that ownership does not change. Service includes transportation of goods and people. Transportation can only take place if there are goods to move or passengers to carry. At the end of the transportation ownership has not changed, when you travel in a bus or aircraft the passenger does not own or get to keep the seat! In other service operations such as a consultant providing advice without the customer the service cannot be provided and again there is no change of ownership. A more mundane example is a hairdresser, without a customer hair cannot be cut! Further examples are a freight train, it can travel from one city to the next but if it carries no freight it has not carried out its function. The same applies to a bus service, the bus can leave the depot and travel around the planned route and finally return to the depot, but unless it has carried a passenger its function has not been fulfilled. The function is to carry passengers not to drive in circles without passengers:

> *A service organization exists to interact with customers and to satisfy customers' service requirements. For any service to be provided, there has to be a customer. Without a customer, and interaction between customer and the service organization, the objective of providing service cannot exist.*
>
> *Wright and Race (2004, p. 4)*

The amount of interaction between the customer and the service providing organization depends on the type of service offered. For example, a computer consultant will have high 'face-to-face' interaction with the customer, whereas service provided over the Internet such as currency exchange conversion calculation will have no face-to-face interaction. Irrespective of the level of face-to-face interaction, without customer input the service cannot be provided. However, this does not mean that the customer always has to be present when the service is being provided. For example, when a vehicle is due for a routine service, once delivered to the garage the driver does not have to be present, but unless the vehicle is available the service cannot be provided. With all of the above resources are held waiting for the input of a customer before an output can be provided. In manufacturing operations the major difference is that ownership changes hands and outputs, that is finished goods, can be stored without customer input.

Manufacturing operations

In manufacturing operations customer interaction is not essential. For example, cars can be manufactured, food can be harvested and processed, hamburgers can be made, and houses can be built, all without customer input. Although it might be desirable that the customer has input into the design and the specifications of the product (be it a car, a hamburger or a house), customer input is not essential. In a 'bespoke' operation the desired policy is to make only to order, that is manufacture will not begin until an order has been received. The limitation of not beginning until an order has been received is self-imposed and can be over ridden. For example, a house builder might prefer not to begin building unless a client has signed a contract, nonetheless the builder can change his strategy and build a house without having a client (in the belief that the house will be sold before it is completed or soon after completion).

Resources

Resources include:

- *Materials*: Materials include the goods that are consumed by the system, goods that are transformed by the system, and finished goods held for sale. Utilities such as fuel, water electricity and gas are also materials. Conversion or transformation refers to changing the shape, form or combination of materials to produce an output. For example, by assembling 12,000 components sourced from a variety of suppliers a car is 'manufactured'.
- *Machines/equipment*: These include plant, fittings, tools, vehicles, storage facilities available to the operating system.
- *Information systems*: This covers the flow of information within the organization, and externally from and to suppliers, customers and other stakeholders. Electronic systems are important communication conduits but they are not the only means of communication in an information system. An information system includes all means of communication, for example speech, newsletters, manuals, brochures, radio, television, etc.
- *People*: People not only means the number of people employed in the operating system, but includes knowledge and skill levels of the people. People also includes the pervading culture of an organization including intangibles of dependability, attitude and shared values.
- *Real estate*: This includes owned, leased or rented; offices, warehouses, factories, display areas, yards, parking space and hard standing, etc.

All of the above represent either a capital investment or an ongoing expense to the organization. Tangible inputs are physical and can be seen and touched, and the amount or rate of use can be measured in quantifiable terms. Intangible inputs are difficult to quantify. They cannot be seen or touched and include knowledge (intellectual capital) culture and values.

Money is not a resource. Money is used to buy resources (people, machines, buildings, etc. are the resources).

Likewise time is not a resource. Time, like money, is used to measure efficient use of resource or performance (e.g. on time delivery, lead time, idle time and down time).

With today's technology there is an abundance of information, indeed there can be an overload of information – how many e-mails did you receive today and how many were actually of use? The concern of the operations manager is to know what information is required and in being able to interpret and use information for the benefit of the organization.

To summarize, in a service organization customer and resources are brought together to provide a service output. For manufacturing input resources are transformed to provide an output, and the customer draws from the system, that is the product is made, and the customer buys the finished good. With a service operation output cannot be stocked, and the service cannot begin without customer input. Wild (2002) developed a set of system structures to illustrate the flow of inputs through to outputs in various systems.

System structures

In considering system structures, Wild uses the following symbols:

O = the transformation process of combining resources including utilities to add value;

V = 'stock' of input resources and output stocks, or 'queue' of customers-waiting to enter the system;

➔ = the flow of resources through the system;

C = the customer. Note, the customer does not have to be external to the organization, but may be an internal customer. The 'internal customer' is the next person, or department, in the process.

V

➔ O ➔

C

Examples

(a) Call centre waiting for customers.
(b) Ambulance or fire service.

Figure 8.2 Customer does not wait.

(Resources) ➔

➔ O ➔

C ➔ V

Examples

(a) Customers waiting in line (queue) for service (e.g. supermarket check out).
(b) Customers make an appointment to see a specialist for advice (e.g lawyer, doctor, hair stylist).

Figure 8.3 Customer queue.

➔ V

➔ O ➔

C ➔ V

Examples

(a) Empty containers in western sea ports in the USA waiting for freight, and at the same time container shortages in eastern sea ports in Asia.
(b) Taxi cabs waiting for fares at the airport, and at the same time passengers frustrated as there are no taxis available at downtown hotels.

Figure 8.4 Idle key resource and customer queue.

Overall there are three basic service or transport structures (Figures 8.2–8.4) and four basic manufacturing or supply structures. Most organizations will consist of a combination of systems.

Service and/or transport structures

For the structure shown in Figure 8.2 the strategy is always to have sufficient of all resources on hand so that the customer never has to wait to enter the system. Service is provided direct to the customer from a stock of resource. 'The stock of resource could be the bus moving from stop to stop, an accident ward waiting for patients, a fire brigade waiting for a call-out, a restaurant waiting for diners, an accountant waiting for customers, or a betting shop waiting for punters. In this structure the customer does not normally wait: the resources do)' (Wright and Race, 2004).

In Figure 8.3 the structure is aimed at efficient use of resource and customers are expected to wait to enter the system. The objective is customers' wait and the key resource is kept fully employed. For example, a business school has resources of lecture rooms and other facilities which are relatively fixed and cannot be used 24 hours a day. The key resource are the lecturers. Students do not determine when the lectures will be, and need to enrol before the semester begins. Lecturers are scheduled for classes (and other duties) and are not paid to have idle time. In some cases such as high profile lawyers and other professionals we would be surprised if we didn't have to make an appointment for a consultation. Thus the consultant's time is not wasted waiting for clients, and clients are conditioned to make an appointment.

In Figure 8.4 the structure implies inefficiency as neither objective of customer service or efficient use of resources is being achieved.

It might be asked why a service system could not be balanced so that there are no idle key resource and no customer queue. The answer is that if customers are never kept waiting there has to be spare resource, or if resources are to be fully utilized with no idle time, there must be a store of customers. Occasionally a balanced system might exist but this will be for a short period of time.

Manufacturing and/or supply structures

Figure 8.5 shows manufacture from stock to stock. For the factory manager this structure is easy to manage. It enables batch and/or level production, and the manufacturing line can be balanced by building to output stock. The downside is that it is expensive in stock holding costs. In the fashion industry and other areas where technology changes, or is likely to change (e.g. electronic goods such as cell phones) there is a danger of the manufacturing organization being left with goods no longer in fashion or which are obsolete.

Figure 8.6 shows that an input stock of materials is held, and once manufactured outputs are delivered direct to the customer (no output stock of finished goods are held). This structure also applies to a retail operation or supply from a warehouse to a customer or to the next component of the supply chain where stocks of finished goods are held and the customer is supplied from stock.

This structure shown in Figure 8.7 applies where it is either not feasible to hold input stocks or it is not desirable to hold input stocks. The customer is supplied from an output stock.

Figure 8.8 shows just in time or lean production. This is best explained by the 'Toyota 72 Hour Car' concept. With this model Toyota holds no stocks of input materials and has no stock of finished cars. The idea is that the purchaser will visit a showroom and be able to see a car indicative of the type of product that Toyota makes. There will not be a wide range of vehicles to inspect; instead the purchaser will be shown on a computer screen the various models available and a list of optional specifications. The purchaser will then select, by keying into the computer, the basic car model and required details such as size of engine, type of transmission, colour scheme, type of upholstery, sound system and so on, but all chosen from a given list. This information will now be electronically transmitted to the factory and to the suppliers of the factory. Within 72 hours the car will be delivered to the purchaser. The benefits include the customer getting what they want. But in fact the customer is now more than just a customer; the customer is now very much part of the manufacturing process. In effect, by keying in their requirements the customer initiates the whole process, raises the raw materials order for the factory, and updates the production schedule. From Toyota's point of view there is a further substantial benefit. Presumably the purchaser will pay on delivery, so there will be no cash flow problems (within a 72-hour period it is unlikely that Toyota will have paid for the materials or for the direct labour). As Taiichi Ohno of Toyota said, we are 'Looking at the time line from the moment the customer gives us an order to the point where we receive the cash. And we are reducing the time line by removing the non-value wastes'. Obviously, a system such as this does not, and cannot, make allowances for mistakes. It relies on good planning by management, quality designed into the product, well-trained workers who are empowered to work as a team, suppliers who are trusted to supply when required and who are also part of the team, an integrated computer system and the elimination of 'non-value wastes'. We challenge you to ring any car dealer, other than for a Japanese brand, and ask how long it would take for a car meeting your various requirements to be delivered. Unless you pick a stock vehicle, and the colour you want is in stock, you are likely to be told that you will have to wait about 72 days!

V ➔ O ➔ V ➔ C

Examples

(a) Manufacture from a stock of input materials and hold a stock of finished goods. Customer draws from the system (e.g. Ford motor company).
(b) Manufacture drawing from own warehouse of materials and stockpile for expected future demand, (e.g. womenís shoes manufactured in winter months for release in spring).

Figure 8.5 From stock to stock.

V ➔ O ➔ C

Examples

(a) Make to order, such as manufacture of a high voltage transformer. High voltage transformers are high capital items and are made to customer specification. It is possible to build a high voltage transformer without a customer order, but few manufacturers would do so, due to the specialised nature of each transformer. Likewise few ship yards would build a cruise liner without a contract from a customer.
(b) Retail or supply from warehouse. Goods are stocked and the customer draws from the system. Unlike service structures, ownership changes hands.

Figure 8.6 Input stock, nil output stock.

➔ O ➔ V ➔ C

Examples

(a) Food processing. Once the food is harvested it goes straight into production. If not processed straight away after harvesting it would deteriorate.
(b) Oil drilling. Once the oil begins to flow it is held in storage tanks.
(c) In a manufacturing operation this structure would apply where materials are ordered just as required, and a stock of finished goods are held.

Figure 8.7 Nil input stock; stock of finished goods.

➔ O ➔ C

Examples

(a) A small house building firm. Materials are ordered as required and once finished the client takes possession (ownership changes).
(b) Just in time or lean production as pioneered by the Japanese.

Figure 8.8 Just-in-time model.

Combined structures

Although seven basic service system structures are shown in the above figures, in reality most service organizations will employ a combination of structures (see Figures 8.11–8.13).

For example, consider the freight consolidator and forwarder. The customer does not have to wait to enter the system, but arranges for a part container load of goods to be left with the consolidator for on forwarding. The structure for this stage is as per Figure 8.9. Note, this is a transport service and ownership does not pass to the freight consolidator.

V
➔ O ➔
C

Figure 8.9 Overall operation freight forwarder.

The freight consolidator and forwarder's policy is to only ship fully loaded containers. The second stage of the operation is out of sight of the customer(s) and is the loading (consolidating) of the container. As this is a separate operation it can be shown as a back room 'factory' type activity (see Figure 8.10). This represents a container being loaded from a stock of goods (waiting to be loaded), culminating in delivery to the destination.

V ➔ O ➔ C

Figure 8.10 Backroom activity.

Figure 8.11 shows the two structures in sequence.

V
➔ O ➔ V ➔ O ➔ C
C

Figure 8.11 Combined structure; freight forwarder.

A further example is the small building firm. The owner of a block of land seeks information from the builder as to what can be built within the parameters of local regulations. The builder has a book of house designs which can be altered to some degree to meet the clients needs. Eventually both parties agree but as the builder is currently working on another house, the client might have to wait 6 weeks before construction can begin. Once the house is completed ownership of the house passes to the client. This combined structure is shown in Figure 8.12.

(Builder) ➔
➔ Oi ➔ Vii ➔ Oii ➔
C ➔ Vi

Figure 8.12 Combined structure; small builder.

Vi = Customer makes appointment to see builder
Oi = Consultancy
Vii = Builder has a ‘stock’ of work waiting to be started
Oii = House constructed

Another situation is where the ‘back room’ activity takes place before the customer enters the system. An example is the breaking down of a bulk consignment by a distributor into small lots in anticipation of small orders from down stream retailers. This is shown in Figure 8.13, the first operation is the

➔ V ➔ Oi ➔ V ➔ Oii ➔ C

Figure 8.13 Preparation in advance of demand.

breaking down and storage of the inwards shipment, the second operation is supplying a retailer from stock.

Five V’s

Slack et al. (2006) also refers to the input–process–output model, but add four V’s of processes to analyse processes. Their four V’s of processes are: ‘Volume, Variety, Variation and Visibility’ to which we have added a fifth ‘Velocity’.

Volume

Processes with a high regular demand will have a high degree of repetition. In operations management this means that tasks are repeated often and it makes sense to train staff to specialize in a limited number of tasks. Tasks become systemized and repeated. Henry Ford back in 1913 is reputed to have said give me a stupid person and in 24 hours I can make that person a specialist, a specialist in a very limited and repetitive operation. With high volume processes the opportunity to mechanize and automate and/or to use robots is obvious. In the supply chain if components can be standardized and common parts are used in the manufacture of different models then ordering in bulk at regular intervals will be possible. The margin for manufacturing errors by the supplier will be minimized and unit costs will reduce. Low volume demand on the other hand is not likely to make high throughput technology cost effective. The same applies to transportation costs. Full containers reduce the cost per unit. Parcel post, where one item sent by courier will obviously increase the unit cost.

Variety

The greater the variety the more stock has to be held and the amount held will multiply with the number of stocking points within the supply chain. As Slack et al. say ‘A high level of variety may also imply a relatively wide range of inputs to the process and the additional complexity of matching customer requirements to appropriate products or services'. So, high variety processes are invariably more complex and costly than low variety ones.

Variation

Under this heading Slack et al. 'say that processes are easier to manager when they only have to cope with predictably constant demand resources can be geared to a level that is just capable of meeting demand' (2006, p. 21). In short all activities can be planned in advance. This applies to ordering materials to arrive 'just in time' and for outputs to be completed to meet demand dates just in time without the need to hold input or output stocks. By contrast when demand is unpredictable buffer stocks will need to be held to cover sudden changes in demand. This applies especially in the fashion industry, for example ladies footwear. The range will be designed months in advance of the next season, but until the new season's pre-orders are received from retailers, and then subsequently once the season is under way and repeat orders flow in knowing what amount and which materials to hold will be difficult. Lower variety eases the stock holding pain, but if variety is too low sales will be lost.

Visibility

Visibility in the supply chain relates to the exposure of the process. In Chapter 15 we introduce the 'bull whip' effect which occurs when each component of the supply chain only receives one way information from the next down stream component. The result is an escalating and wildly fluctuating demand pattern known as the bull whip effect. If information is shared, that is visibility of the intensity of the bull whip effect can to some extent be softened. Front office is usually highly visible, that is in materials movement acceptance of goods for consolidation, but the consolidation and transportation is not visible to the customer. Visibility can be increased for goods in transit by the use of bar coding or RFID tags to track movement of materials. In general, processes that are directly in contact with customer (e.g. retail) should have more visibility than those that are carried out in an office or a factory.

Velocity

Velocity, or time, is an important aspect of supply chain management. Measurement of time performance are:

- time taken to fulfil orders (lead time),
- time taken at each stage of the supply chain,
- delivery on time,
- age of stock (used by dates),
- numbers of days of stock on hand,
- stock turn.

A process related to lean and agile supply chain (see Chapter 13) should increase its velocity.

The Supply Chain Council (www.supply-chain.org/) recommends a metric system for performance covering the four areas of customer satisfaction/quality, time , cost and assets. They provide a range of measures for each category and also provide benchmarking for their members. A sample measure is supply chain response time (SCRT).

This represents the measure of time taken to recognize and react to changes in demand. For the Supply Chain Council perfect order fulfilment only occurs when all orders are delivered in the quantities required, on the agreed delivery date, and documentation is complete and correct, and the goods are received in perfect condition and meet specification.

Infrastructure facilities

What are infrastructure facilities? They include factories, offices, equipment and hardware, conversion technology and third party suppliers/service resources. Infrastructure facilities do not include people, procedures and systems. Here we consider the challenge for selecting the most appropriate infrastructure facilities, and whether this challenge differs for manufacturing and service industries?

The challenges of infrastructure facilities are far more complex than cash flow management, and the parameters are not of the short-term nature of labour and software. The outcome of an investment decision for a manufacturing facility is likely to last for 10–100 years. Likewise, it normally takes several years of disciplined effort to transform an existing weak service unit into a strong unit.

Manufacturing sector

Skinner (1969) described manufacturing facilities as either a corporate millstone or a competitive weapon depending on the strategy applied and pursued. As Hayes and Wheelwright (1985) observed in a manufacturing business, a number of interrelated functions (such as marketing, innovation, engineering, purchasing, manufacturing and distribution) work towards a common objective of satisfying the customers and at the same time ensuring an attractive return on investment for the shareholders.

Of these, the manufacturing function share the organizations assets and people. According to Hayes and Wheelwright the four stages in the strategic role of manufacturing are as follows:

- *Stage 1*: Minimize manufacturing's negative potential: 'internally neutral' manufacturing is kept flexible and reactive.
- *Stage 2*: Achieve parity with competitors: 'externally neutral' capital investment is the primary means for catching up with competition.

- *Stage 3*: Provide credible support to the business strategy: 'internally supportive' longer-term manufacturing developments and trends addressed systematically.
- *Stage 4*: Pursue a manufacturing-based competitive advantage: 'externally supportive' long-range programmes pursued in order to acquire capabilities in advance of needs.

In a typical fast-moving consumer goods (FMCG) manufacturing business:

- 98 per cent of the products sold are either own manufactured or co-produced.
- 90 per cent of the assets of the company are for manufacturing.
- 75 per cent of the people work in manufacturing.

It is not enough just to formulate and pursue an 'up front' manufacturing strategy, no matter how good the strategy is. To maintain a competitive advantage it is essential to support the strategic planning of facilities with the ongoing monitoring of performance and with continuous improvement programmes. The management of manufacturing facilities should be dynamic with the relentless pursuit of the elimination of unnecessary non-value adding expense and always with the objective of adding value for customers. Competitive advantage once achieved through a strategy such as investment in new facilities will require hard work if the advantage is to be retained.

Service sector

A service business is one where the perceived value of the offering to the customer is determined by the service rendered than the product offered.

This intimacy of a customer in a service function has led to the perception that service cannot be stored and has to be produced and consumed simultaneously. Of course, there are some services which have to be produced at the delivery point, such as emergency medical treatment. However, in a higher proportion of services the activities which can be isolated from the interaction of the customer are uncoupled from the organization. The isolated operations can be managed using the similar methods as used in manufacturing operations. The examples of these types of services include tailors, banks and hotels. Whether it is a small scale or a large-scale operation, all services can be grouped as direct services or isolated services as shown in Table 8.1.

The strategic and operational considerations related to infrastructure facilities for isolated services are likely to be similar to those for manufacturing operations. For direct service also, it can argued, that manufacturing principles can be selectively applied such as the application in fast foods services. Mass service is often like pre-setting the work outside the machine running cycle in a mass production packing line.

Table 8.1 Categories of services

	Direct service	Isolated service
Small scale	Professional service (e.g. Doctor, Hairdresser)	Service shop (e.g. Garage, Tailor)
Large scale	Mass service (e.g. University, Supermarket)	Service factory (e.g. Banks, Post-office)

Adapted from Schmenner (1993).

Summary

This chapter has explained the importance of operations management in the context of supply chain management. To do so the traditional operations management input–process–output model was introduced and extended to include system structures. The five V's of Volume, Variety, Variation, Visibility and Velocity were explained and how these 'V's' can be managed to add value (yet another 'V') for the supply chain. The chapter concluded with a section re infrastructure facilities. There are many books, including *Total Operations Solutions* by Basu and Wright (2005), dealing with detail processes in operations management. Our primary objective of this chapter is to set the critical role of operations management as a building block in the physical flow of the total supply chain.

9

Distribution management

Introduction

The physical movement and delivery of goods and services to customers is a key objective of supply chain management. The three key aspects of customer service are specification, price and timing. Specification and timing are often measured by the metric, ‘on time in full’ and are the direct result of distribution management. Distribution management is closely linked with the ‘customer intimacy’ model of Treacy and Wiersema (1993) but many organizations outsource distribution management to third-party hauliers thus reducing the frequency of direct customer contact.

Web-based software and e-market places have increased opportunities available to e-supply chain managers in all operations including the service industry.

Information technology and the Internet has improved the access to information, enabled currency transactions, and improved data accuracy. However the real effectiveness of supply chain management is the physical movement of materials from source to customer. Important components for every e-commerce, on-line trading and virtual supply chain are factories, warehouses and transport.

It is vital that a physical distribution process is in place to ensure the performance of e-supply chain for both virtual and physical activities, but it is well recognized that supply chain order fulfilment is the Achilles heel of the e-business economy.

This building block, distribution management addresses the challenge of distribution efficiency under three headings:

1. Physical distribution
2. Strategic alliances
3. Customer relationship management

Physical distribution

In the same way that enterprise resource planning (ERP) is concerned with information flow, suppliers and inbound logistics, distribution management is likewise concerned with materials flow, customers and outbound logistics. Inbound logistics is characterized by demand variability, and outbound logistics is characterized by variable service levels.

With the management of distribution, that is the physical transportation of goods from the factory through the various components of the supply chain to the customer, invariably some stock will be held in the system to buffer the variability of demand and to make allowance for vagaries in supply lead times. The focus on outbound logistics is to balance customer service level against cost. Cost of distribution is not just transportation costs but also includes warehousing including special requirements such as refrigeration, insurance and financing of stock, and stock slippage (deterioration, damage, pilfering and obsolescence). The more stock that is held the greater the cost of storage and the greater the chances of losses.

The main components of distribution management are:

- Distribution strategy
- Warehouse operations
- Stock management
- Transport planning

Distribution strategy

It is important that a company in a consumer focused business has a defined distribution strategy. The first criteria of distribution strategy is to decide whether the management of activities should be by the company or by a third party. With assets (buildings, equipment and transport vehicles) the strategy can go three ways:

1. Own the assets or some of the assets
2. Lease or rent assets
3. Contract (outsource)

Some of the various strategy mixes are shown in Table 9.1. Note there are 64 possible combinations, for example own premises, leased premises, own management of premises, third-party management of premises, own transport, leased transport, or third-party supplied and managed transport, and so on. Table 9.1 shows 24 of the most likely combinations.

There are some obvious advantages of distribution management by a third party, for example the distribution expertise of third-party companies, the avoidance of capital outlay and under utilized equipment. It has become a popular practice with many original equipment manufacturers (OEMs) organizations to outsource warehousing and transport to third-party companies. However, as the delivery of the finished products is closest to the customer on the supply chain, there could be some degree of risk if the management of outbound logistics is totally left to third parties.

A distribution strategy is significantly influenced by: economic factors, channels of distribution and their location, location of service centres and warehouses. Shorter channels are ideal especially for perishable items, services

Table 9.1 Distribution strategy combinations

	Warehousing		Transport	
	Building	Operation	Trunking	Delivery
Strategy A	Own	Own	Own	Own
Strategy B	Rent	Own	Leased	Own
Strategy C	Rent	Own	Third party	Third party
Strategy D	Own	Own	Third party	Third party
Strategy E	Rent	Third party	Third party	Third party
Strategy F	Rent	Own	Own	Own
Strategy G	Own	Own	Third party	Own

requiring closeness to customers, and urgent products. An intermediary in the channels of distribution can reduce distribution costs where; the sources of supply are not in abundance, there are numerous destinations, or transportation is difficult or expensive. The choice of location is usually driven by cost objectives for warehouses and manufacturing facilities and by revenue objectives for service type operations. With the impact of Internet the distance of a service centre to customer has become less important.

Channels of distribution

It is important for a manufacturer of fast-moving consumer goods (FMCGs), that the distribution strategy should consider the opportunities for both present and future business through an appropriate mix of the channels of distribution. Examples are:

Factory to:

- distributor,
- wholesaler,
- supermarket,
- direct to end user (e.g. Dell).

The distribution strategy should also include the company policy of exclusive agents or stockists and of direct mail or on-line order to end users. Figure 9.1

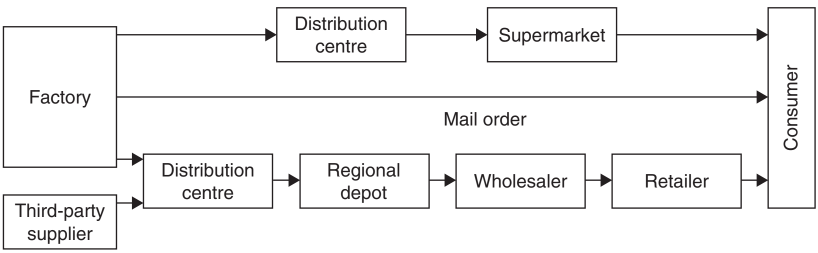

Figure 9.1 Channels of distribution.

illustrates an example of the channels of distribution in a typical FMCG business. The selection of a strategy may be influenced by the cost of distribution and it should be tempered by the business judgement of customer service and future opportunities.

The channels of distribution is also determined by the stages required to deliver products or services depending on the type of business. An organization exercises more control or influence on the service for a single stage channel, that is delivering product or service directly to the customer. If, however, more stages exist with intermediaries between the organization and the customer then each party may have some influence over such decisions as stock holding, service levels and market cover. Table 9.2 shows typical examples of stages in distribution channels in different kinds of organizations.

Table 9.2 Stages in distribution channels

Original Equipment Manufacturer (OEM)	No. of stages	Intermediaries
Manufacturing sector		
Civil Engineering	1 (direct)	
Foods manufacture	2	Supermarket
Car manufacturer	4	Overseas agent
		Distributor
		Retailer
Service sector		
Original supplier	No. of stages	Intermediaries
Hairdresser	1 (direct)	
B2C Internet sale	2	Transporter
Hospital	2	Doctor
Charter Airline	3	Holiday company
		Travel agent

Facilities location

Another important aspect of distribution strategy is location of distribution warehouses. The location, design and operations of distribution warehouses are all vital ingredients of a supply chain – not only for cost optimization but also for the quality and safety standards of products and for improving customer service by a faster turnaround at the warehouse. There are computer simulation models available for determining the size and location of a distribution centre, but local body planning regulations, the proximity of a highway and a big demand centre very often will be the prime determinants of the location.

The location of a warehouse can be influenced by many factors both objective and subjective. The factors which generally affect the selection of a warehouse site can be grouped in three sets of factors:

1. Cost factors
2. Revenue factors
3. Local factors

The cost factors have three main components: variable cost, fixed cost and inventory cost. The variable cost of a warehouse operation include the costs of labour, material and utilities. The accessibility to labour and materials will affect the variable cost. The fixed costs are associated with the provision and maintenance of facilities and the cost of security services. When the number of facilities is reduced there is a saving in the fixed cost. If we, for example, centralize the inventory of a number of warehouses to a single location the base stock will remain the same but the safety stock will reduce according to the following equation:

$$S_n = S_1(n)/\sqrt{n}$$

where S_n is the sum of safety stocks for n locations,
S_1 is the safety sock for 1 location, and
n is the number of locations.

The location of a retail outlet or service centre has traditionally, and for obvious reasons, been determined by the proximity to customers, or expected growth of population (and future customers) in the region. The opening of a warehouse, such as Ikea, in the proximity of a town has been known to increase the revenue in that town. With the impact of e-commerce the traditional ‘bricks and mortar’ locations are now to some extent challenged by ‘clicks and mortar’, nonetheless large new super stores and shopping malls continue to open and to prosper.

The local factors influencing the selection of a location include management preferences, congeniality of the district, local infrastructure and transport network, industrial relations and availability of trained labour. There are often incentives or investment grants available to encourage organizations to establish facilities in areas designated for regeneration or industrial development.

Case example: Warehouse location

The brief: After the merger between Fosroc* and Expandite in England the joint operation had main warehousing facilities in the neighbouring towns of Tamworth and Greenford, with a smaller warehouse at St Helens. As a result of a logistics structure review, the client decided to rationalize the warehousing facilities by centralizing and consolidating all finished goods in a single facility on their production site in Tamworth. It was agreed that the best approach to producing a building which would efficiently meet their requirement was to design the facility '*from the inside out*'.

The approach: Due to the sensitive nature and possible closure of warehousing it was important to keep the study confidential. The project started with a feasibility study into various configuration options. As the client had available land to build the new warehouse, a study into the location was not needed and this meant that we could start calculating the required size immediately. The stock was analysed and activity data from the three warehousing locations to work out the site size needed in conjunction with the proposed layouts. After the decision on the favoured design had been made, the option was developed to the level where the scheme could be put-out to a design and build organization for tendering. During this stage detailed analysis was produced of proposed floor space, equipment requirements and pallet racking locations. Another aspect of the project was the production of staffing requirements together with a staff structure diagram.

The result: The floor space was reduced from the three combined units of 80,000 to 50,000 square feet in the new single distribution centre by removing duplication of stock and improving operating techniques. Also, reduced were staffing levels by 30 and other costs.

Trade counters with minimal stock holdings at the old sites were retained but the major storage facilities were closed. Due to its central location, the new warehouse provides consistent, accurate delivery throughout mainland UK within 3–4 working days from receipt of order.

**Fosroc Expandite* is one of the largest manufacturers of construction and civil engineering products in the world.

Source: Supply Chain Planning UK Ltd. (2007)

Warehouse operations

The operations of a distribution warehouse in general, can be represented by Figure 9.2. There are good opportunities of 're-engineering' the warehouse functions when the total process from reception to despatch is critically examined.

The design issues of a warehouse include:

(a) Storage systems
   – block stock
   – back-to-back racking
   – double deep racking
   – narrow aisle racking
   – drive-through racking
   – mobile racking
(b) Handling systems
   – counterbalanced trucks
   – reach trucks

– turret trucks
– stacker cranes
– automated guided vehicles
– overhead cranes

(c) Product quality
– ambience
– chilled store (e.g. margarine)
– cold store (e.g. ice cream)

(d) Safety and control systems
– detection systems
– sprinkler and fire hydrants
– warehouse management system (WMS) software

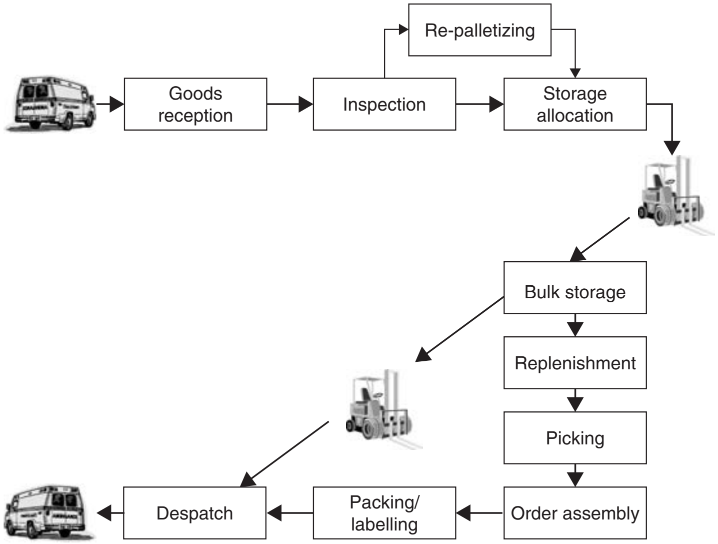

Figure 9.2 Warehouse operations.

In view of the above inter-related design issues there should be a structured approach for designing a warehouse. We suggest the following steps:

1. Calculate pallet positions by taking into account:
   – annual volume
   – stock policy (amount of safety stock)
   – units or kg per pallet
   – variability of stock keeping units (SKUs) (peak, growth)
   – lead times from suppliers
2. Evaluate functional options of storage and handling systems
3. Establish quality requirements (e.g. chilled)
4. Establish systems and infrastructure
5. Select the location of the warehouse
6. Estimate budget costs (±15 per cent accuracy)

Example: Pallet calculation

The calculation of pallet positions is illustrated by the following worked out example:

- *Given data*
  - Annual demand 12,000 tonnes
  - Load per pallet 400 kg
  - Stock turn 13
  - Weekly peak 1.2 × average
  - SKUs 4 (same weight)
- *Calculation*
  - Weekly demand = 12,000/52 = 230.8 tonnes
  - Pallets for 4 weeks = (230.8 × 4)/0.4 = 2308
  - Allowing 20% for peak and 85% pallet utilization, pallet positions = (2308 ×1.2)/0.85 = *3258 pallets*

7. Evaluate financial and risks options including own or rent

The following case example illustrates an outline design process of the physical requirements of a warehouse in response to an invitation to tender.

Case example: Warehouse design

Background: Zigafroos Consolidated Industries (ZCI) is the UK's leading importer of high-quality consumer electrical goods for the independent retailer. The current storage centre in Edgware, London, is at the end of the lease period and is not considered adequate for future operations. The company is also considering offering operation of the storage centre to a third-party logistics (3PL) partner. You are therefore invited to tender for the sourcing, design and operation of a new dedicated storage centre. The tender will be a two-stage process, with the first stage concentrating on defining the physical requirement for the new facility.

The operation: ZCI purchases product from multiple overseas sources. Stock is delivered to the storage centre in 20 or 40 feet sea van containers and is generally loose loaded. Stock is stored pending orders and picked for a network of independent regional wholesalers. Currently there are 25 wholesalers covering all of the UK. Stock availability is declared to wholesalers electronically and orders passed to ZCI on a weekly basis. Stock picking is at the individual carton level and orders are built up for delivery to wholesalers on multi-SKU pallets. The manufacturer arranges transportation into the UK, customs and port clearance and transport to the warehouse are sub-contracted by ZCI as is delivery to the wholesalers. Volumes and stock characteristics are available. ZCI is planning on 5 per cent growth year on year.

Given data: In addition to the above information ZCI has provided the results of an internal study to estimate the peak pallet holding for 2002. The calculation is shown in a spreadsheet which contains the following summary data for 2002:

- Annual sales 217,390 boxes
- Product groups 49
- SKUs 1839
- Peak stockholding 8385 pallets*

* Euro pallets 800 mm × 1000 mm

Next step: Based on these submissions the Zigafroos board will short-list prospective partners and issue a comprehensive request for proposals.

Please deliver your proposal to our Edgware offices for the attention of Mr Harry Zoogorilla.

Exercise

Provide your recommendation on size and configuration for new Zigafroos Storage Centre. Address the following issues:

1. Size of warehouse required: design for 5 years of growth
   - Maximum pallet positions for design
   - Approximate area for the chosen storage method**
2. Outline layout
   - Pallet and shelving configurations
   - Picking and despatch area
3. Recommended mechanical handling equipment

Provide the rationale for your choice of design and equipment and an indication of your company's experience with this type of operation

** As a rough guide for estimating approximate area for given pallet positions you may use the data in the following table:

Approximate area (square metres) requirement per 100 pallets

Pallet dimension 1200 mm × 1000 mm

	2 high	3 high	4 high	5 high
Wide aisle	138	92	69	46
Narrow aisle	117	78	59	47

Note: If 6 or higher is required the area needed can be prorated.

Sample solutions

Answer to Question 1

Compound growth for 5 years at 5%	=	27.6%
Peak stockholding after 5 years	=	1.276 × 8385
	=	10,701 pallets

Assuming 5 high narrow aisle, approximate storage area
$= 10{,}701 \times 47/100$
$= 5034$ square metres

Answer to Question 2

The outline layout will depend on the configuration of the space available. Assuming a greenfield site, a configuration could be:

Width of the warehouse	100 m
Span between columns (bay)	17 m
Storage space	= 3 bays
	$= 3 \times 17 \times 100$
	= 5100 square metres
Picking and despatch area	= 2 bays
	$= 2 \times 17 \times 100$
	= 3400 square metres
Total warehouse area	= 8500 square metres

Answer to Question 3

For a narrow aisle five high warehouse recommended mechanical handling equipment:

Storage and retrieval	Reach trucks
Despatch area	Counterbalanced Fork lift trucks
Picking area	Hand pallet trucks

Stock management

As indicated earlier in Chapter 7, stocks are kept as a buffer along the supply chain in various warehouses, factories (work in process) and retail store shelves. These inventories can cost between a minimum of 15 per cent up to 40 per cent of their value per year (storage space, handling costs, energy costs including heating and refrigeration, stock slippage and insurance). Therefore, careful management of stock levels makes good business sense.

In traditional stock management there are two basic approaches see Chapter 7, namely the pull approach and the push approach. In a pull system a warehouse is viewed as independent of the supply chain and inventory is replenished with order sizes based on a predetermined stock level for each warehouse. The stock management model for the pull system is normally geared to establish re-order level (ROL) and re-order quantity (ROQ). That is, when the stock drops to a certain level, a re-order is triggered of a predetermined amount. The ROQ takes into account past demands and the lead times for a re-order to be satisfied. The aim is to have as small amount of inventory as possible on hand at any one time, and the ROQ should likewise be as small as possible. However in some processes, such as a batch system, there will be a minimum amount that can be produced and in other cases there can be economies of scale which will determine the optimal size of an order. The push method is used when economies of scale in procurement outweigh the benefits of minimum inventory levels as achieved in the pull method. That is, the warehouse does not decide the quantity of the order but will receive a delivery as determined by the production schedule. Normally, a fixed interval review model with a forecast demand for manufacturing planning is used in a push system.

With the support of information technology, businesses are moving towards a virtual inventory system with a single stock concept which can be held anywhere in the system, be it on order with the supplier, in production or at the point of sale (POS). This is the concept of virtual inventory management (VIM) or electronic inventory. Thus instead of considering stocks of raw materials, work in progress at the various stages of production and finished goods in warehouses each as separate stocks of inventory, purely because of their physical location, inventory is now considered as being part of one single stock.

The movement and management of inventory in a warehouse is further enhanced by the application of advanced technology such as warehouse management systems (WMS) and radio frequency identification (RFID).

The evolution of WMS is very similar to that of many other software solutions. Even though WMS continues to gain added functionality, the initial core functionality of a WMS has not really changed. The primary purpose of a WMS is to control the movement and storage of materials within an operation and process the associated transactions. Directed picking, directed replenishment and directed put away are the key to WMS. The key functionality of a WMS must include:

- A flexible location system.
- User defined parameters to direct warehouse tasks by using live documents.
- Built-in level of integration with data collection devices or an established ERP system.

RFID is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags. An RFID tag is an object that can be attached to or incorporated into a product, pack or pallet in a warehouse for the purpose of identification using radio waves. They may not ever completely replace barcodes, due in part to their higher cost, but with the advantage of more than one independent data source on the same object the application of RFID is likely to grow in supply chain management.

Case example: FDA tracks drugs supply

The Food and Drug Administration (FDA) of the USA announced in February 2004 new steps to strengthen protection against the problem of counterfeit drugs in the supply chain. The agency's Counterfeit Drug Task Force recommended RFID tags to track drugs from the source to the POS.

The Prescription Drug Marketing Act of 1987 requires drug distributor to provide documentation of drug products throughout the distribution system. This chain of custody of medicines is also known as 'pedigree' regulation. The Task Force outlined the new measure in a report to safeguard the drug supply with the use of electronic track and trace technology such as RFID. This would create an electronic pedigree for tracking the movement of drugs through the supply chain. This report recommends that drug manufacturers and distributors continue to work toward that goal and that their implementation of RFID technology be used first on products which are most susceptible to counterfeiting.

In order to ensure the appropriate usage of RFID technology the recommendations from the Task Force also include:

- Consumer education about RFID and the labelling of RFID tagged products.
- When RFID tagged drugs are dispensed to consumers there should be protection of consumer privacy to prevent unauthorized information stored in RFID tags.

'We intend to work with industry and standard setting organizations to explore the feasibility of allowing FDA to access relevant electronic pedigree information, as that information would greatly improve our ability to minimize exposure of consumers to counterfeit drugs by facilitating rapid criminal investigations of illicit transactions', Dr. L M Crawford, Acting FDA Commissioner added. The FDA also applauded the initiatives announced by the pharmaceutical companies Pfizer, GlaxoSmithKline and Purdue Pharma.

Source: FDA (2004)

Transport planning

Transport planning is a key decision area of distribution management. Transportation is a non-value-added item to the cost of the product and absorbs, in general, the biggest share of the logistics cost. Students often argue that unless a product is in the right place it is of little value and thus transportation does add value. Not so! The concept of adding value relates to the transformation process, that is the conversion of inputs of raw materials, labour and machinery into a finished product. Storage, inspection and transportation all add cost but do not add value. Some of these costs will be unavoidable; materials have to be moved, goods have to be distributed, but storage, handling and movement only add to the cost, and not to the value of the product.

The main factors in transport decisions are (see Figure 9.3):

- Transport mode selection.
- Trucking routing.
- Delivery planning.

There are various means of transportation such as railway, river, canal, coastal shipping and pipelines for products such as oil. In some countries, for some products, air transport might prove to be the most viable option. Generally however because of dependability, flexibility, speed and door-to-door service, road

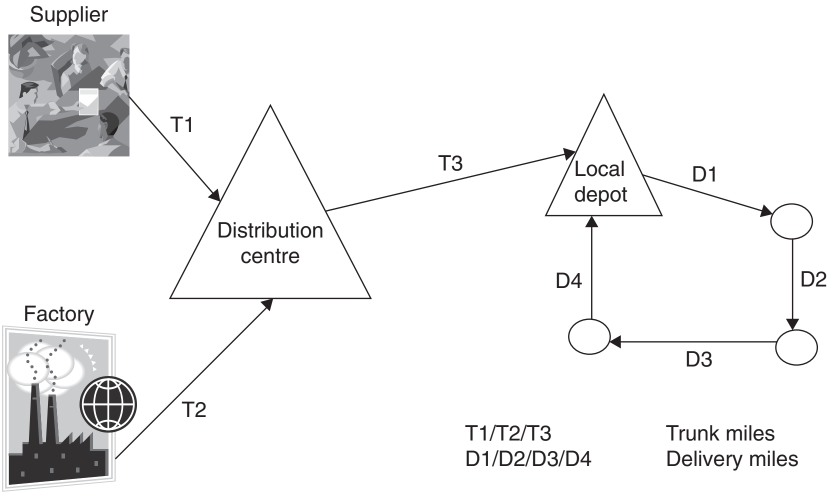

Figure 9.3 Distribution routes.

transport has proved to be the best option. For the UK, the Channel Tunnel has added to the convenience of road transport to and from Europe.

There are significant opportunities in optimizing the selection of hauliers or type of trucks. In order to take advantage of the competitiveness and the up-to-date development of vehicles, companies are building partnerships with hauliers. After the selection of the mode, the planning of trunking or primary transport for single-drop repetitive journeys between known or well-known locations (e.g. factory to warehouse), is relatively straightforward. However, the routing and scheduling of delivery vehicles to customers is extremely variable and therefore requires more systematic planning. There are computer-based procedures to optimize delivery to customers. The objective is not to minimize the total mileage but to maximize the utilization of vehicle time (delivery window) and space (by volume or weight) and ensuring customer service.

Case example: Fresh foods – Christian Salvesen

Christian Salvesen is a major logistics business specializing in the strategic management of outsourced supply chains.

A key task of Christian Salvesen is defined in its mission statement as: 'To meet customer service requirements consistently and reliably through a mutually cost effective supply chain'. This usually takes some time to achieve, not because it is either complex or controversial but because the supply chain can mean different things to different people. Furthermore, although the objectives are unanimous, the way in which each organization achieves them through their respective supply chains is different.

According to the Logistics Director 'It is these two elements – customer service and resource efficiency – that drive any supply chain'.

Let us examine Christian Salvesen's experience in implementing these principles in the area of the supply of fresh foods through Evesham chilled depot. Here is a product group whose availability is measured in hours. Meticulous planning and co-ordination is required to customer demand in rigid 'delivery windows' and plans have to cope with most unpredictable element of a supply chain – Mother Nature.

Evesham is a chilled depot of approximately 20,000 square feet situated in the Vale of Evesham in Worcestershire, which is one of the major produce growing areas in the UK. It has a staffing level of 94 and nearly half of them are qualified reefer vehicle drivers. It is a stockless depot for cross docking operation under temperature controlled conditions. The main function of the depot is to act as a consolidator of suppliers produce and chill products received from various parts of the country, for subsequent onward despatch to the majority of the UK and Irish Regional Distribution Centres. It is a stockless depot for cross docking operation.

Operating on a 24 hour/7 day a week (24/7) basis Evesham is a critical link in the fresh food temperature controlled supply chain, and allows the speediest possible route from field to plate thus preserving both product quality and maximum shelf life. The depot has an operating revenue budget of £7.6 million from which it generates a return on investment (ROI) of 21 per cent and a profit margin of 10 per cent.

The depot is subject to seasonality due to the nature of its core volume product, but continues to develop its year round chill business. The majority of its profits however are derived during the summer months of the produce season. Volumes peak during August at a throughput of 7600 pallets per week, with a peak day activity of 1600 (21 per cent) pallets.

Regular daily collections are made from suppliers/packers during the day and return to the depot during the afternoon/evening. Product is off loaded into a cross dock/straight through chilled warehouse facility where it is sorted for onward delivery destination and despatched anytime from 16.00 hours onward through until 01.30 that night.

Orders from the major retailers would have been received into Evesham between the hours of 11.00 and 17.00 that day. A typical example of the complexity of the physical operation would be for suppliers such as Flamingo/Wealmore which are based in the North West of London.

10.00 Vehicle leaves Evesham to collect clean empty trays from Corby for delivery to Flamingo.
16.00 Arrives at Flamingo, off loads trays and reloads half the vehicle with product for that days retail orders.
17.00 Arrives at Wealmore to collect balance of load for that days retail orders.
20.30 Arrives back at Evesham to off load product into chill warehouse where it is sorted into delivery destinations for Ireland and Scotland.

Tesco – Dublin/Belfast/Livingston
Safeway – Bellshill
Asda – Grangemouth
Somerfield – Pitreavie
(Irish product would leave asap).

23.00 Vehicle leaves for Salvesen depot at Ormskirk in Lancashire.
01.30 Arrives at Ormskirk where further product is put on (Ormskirk is a produce growing area) and the trailer is then taken on to Scotland by an Ormskirk driver, with the Evesham driver returning with another trailer (may be loaded) to Evesham.
07.30 Arrives at first of Scottish delivery points.

On completion of deliveries the vehicle would go into the Salvesen operation at Camerons Wood (Livingstone, Scotland) to confirm all activities onto the Salvesen 'Track and Trace' Sharp system (confirms visibility of delivery to customer). The vehicle may then reload with produce or soft fruits collected earlier by Camerons Wood from the Scottish growers, and return it via the Ormskirk changeover link into Evesham for consolidation and onward delivery to the retail RDC's (Re-distribution Centres).

The transport fleet at Evesham comprises 34 owned tractors supported by 53 temperature controlled trailers including 40 hired trailers. In addition to 10 tractor/trailers based Ormskirk the operation has the flexibility to 'buy in' extra resource from other depots in the Salvesen temperature controlled network. The hired tractors are made up of both long-term rental contracts and short-term casual hire to meet the variable demand and seasonality in a changing market.

Currently Salvesen covers the following retailer RDC profile for fresh foods:

Tesco	11
Safeway	8
Somerfield	7
Asda	8
CWS	2
M&S	3

The service level agreements with retailers include that delivery should be made within the limit of the delivery window. Any significant variation of delivery time is subject to penalty. There is no buffer stock, as such a short shelf life of such a perishable product group does not allow for it. There are also other challenges, such as forecasting the effect of weather or promotions. The supply chain cannot afford any shortage of refrigerated trucks of appropriate capacity when needed. Even we achieve 100 per cent availability on all products it may count for nothing if the absenteeism of drivers is out of control.

Exercise

1. What are the customer service and resource utilization objectives at Evesham?
2. What are the demand planning and supply planning problems at Evesham? Outline a strategy to deal with these problems.

Sample solution
The customer service objective at Evesham is to provide fresh food products on time in full to RDCs according to their delivery windows. The most important criteria is timing. The compromise is for cost. However the reefer supply is now moving from a specialist business to a commodity business and thus the cost should be competitive. Thus cost is of medium importance. The specification is also of medium importance. Students may argue that as the customer expects all deliveries in right quantity in controlled temperature the specification should be of high importance, but the quality of product is the primary responsibility of the farmers.

The resource utilization objective is maximizing the utilization of resources owned by the company – people (drivers) and facilities (own vehicles). Facilities refer to those owned by the depot. The materials are not owned by the depot and stock control is not an issue. As the products are handled in controlled temperature the importance of materials is medium.

The capacity management strategy should be to provide an efficient adjustment of capacity.

As output stocks are not feasible an efficient adjustment of reefer vehicle capacity has been provided. The depot provided own and contract vehicles (34 tractors and 53 trailers) to cover the average throughput (e.g. 1100 pallets per day = at 20 pallets per trailer, 55 trailers). In addition 10 tractor/trailers from Ormskirk are available to adjust for variation and seasonality.

Of the 94 staff nearly half of them are qualified drivers. Therefore, some extra capacity of drivers are planned to cover for both variations and absenteeism.

Because of the agreed delivery window the principle of ‘backward scheduling’ is applied. A route scheduling optimization programme is available to provide recommended schedules, based on which final adjustments are made by the route planner.

In order to improve the exchange of information the company has installed EDI (electronic data interchange) systems with some supermarkets.

Source: Christian Salvesen, UK (2002)

Strategic alliances

In order to achieve an integrated supply chain the various players need to work together. The four most important types of distribution management strategic alliances are third-party logistics (3PL), retailer–supplier partnerships (RSP), distributor integration (DI) and customer relationships management (CRM).

Third-party logistics (3PL)

The use of a third party to take over some or all of a company's logistics responsibilities is becoming more prevalent. 3PL is simply the use of an outside company to perform all or part of the firm's materials management and product distribution function. 3PL relationships are typically more complex than traditional logistics supplier relationships. Modern 3PL arrangements involve long-term commitments and often multiple functions or process management. As organizations focus on their core competencies they are looking for other specialist organizations to partner with.

Retailer–supplier partnerships (RSP)

As customer satisfaction becomes more imperative and margins get tighter it makes sense to create co-operative efforts between suppliers and retailers in order to leverage the knowledge of both parties. The types of RSP can be viewed on a continuum. At one end is information sharing. At the other is a consignment scheme of vendor-managed inventory (VMI), where the vendor completely manages and owns the inventory until the retailer sells it.

In a simple quick response strategy, suppliers receive POS data from retailers and use this information to synchronize their production and inventory activities with actual sales at the retailers. In this strategy the retailer still prepares individual orders, but the POS data is used by the supplier to improve delivery performance and hence reduce supply variability.

In a continuous replenishment strategy, sometimes called rapid replenishment, vendors receive POS data and use this data to prepare shipments at previously agreed intervals to maintain specific levels of inventory.

In a VMI system, the supplier decides on the appropriate inventory levels of each product and the appropriate policies to maintain these levels. The goal of many VMI programmes is to eliminate the need for the retailer to oversee specific orders for replenishment. The ultimate is for the supplier to manage the inventory and only receive payment for it once it has been sold by the retailer in essence the retailer is providing an outlet for the supplier!

Distributor integration (DI)

Modern information technology has enabled this strategy in which distributors are integrated so that expertise and inventory located at one distributor is available to the others. DI can be used to address both inventory- and service-related issues. In terms of inventory, DI can be used to create a large pool of inventory across the entire distributor network thus lowering total inventory costs while raising customer service levels. Similarly, DI can be used to meet the customers specific needs by directing those requests to the distributor's best suited to address them.

The influence of the Internet on the economy in general and business practice in particular has been tremendous. The direct business model employed by industry giants such as Dell Computer and amazon.com enables customers to order products over the Internet and thus allows these companies to sell their products without relying on third-party distributors apart from those providing the physical delivery service.

Similarly, the Internet and the emerging e-business models have produced expectations that many supply chain problems will be resolved merely by using these new technology and business models. Whilst it has promised so much in reality the expectations have not been achieved. In many cases the downfall of some of the highest profile Internet businesses has been attributed to their logistics strategies.

Whilst the success of the business to customer concept has not yet eventuated the use of the Internet for business to business integration has more likelihood of success. Integration of the supply chain players is made possible with the use of the Internet and the associated technologies.

Reviewing the impact of the new technologies on the supply chain provides an interesting development. The Internet and the evolving supply chain strategies has seen a shift in transportation and order fulfilment strategies away from case and bulk shipments to single item and smaller-size shipment and from shipping to a small number of stores to serving highly geographically dispersed customers. This shift has seen the importance of partnerships with parcel and LTL (less than truck load) industries. It has also increased the importance and complexity of reverse logistics, that of handling the significant numbers of product returns. Thus, one of the big winners in the new developments is the parcel industry. Indeed one of the important advantages of the parcel industry is the existence of an excellent information infrastructure that enables real-time tracking. Those players in this industry who work to modify their own systems in order to integrate it with their customers' supply chains are likely to be successful.

As businesses come to understand the role of the Internet we will see new models of business evolving. As yet what those models will be is unsure, but one thing is for certain the Internet will have an impact on how supply chains of the future will be managed.

Customer relationship management

The recent growth in availability of customer relationship management (CRM) systems has lead to access to data that can be used to improve overall supply chain performance. The objective of CRM is to develop a customer-centred organization that ensures every opportunity is used to delight customers, foster customer loyalty and build long-term relationships that are mutually beneficial. The ultimate goal is to ensure that each individual customer's current and future wants and needs can be satisfied. What this involves is the capture of individual customer transaction details and from this historical data developing a picture of what that customer needs and purchasing habits are.

CRM's relevance to overall supply chain management lies in the need to integrate such systems with the management of the supply side. The information gathered by the CRM systems can be used to improve the overall performance of the complete supply chain. As the need for supply chain transparency increases, businesses are looking for ways to improve the efficiency of supply. This has lead to the development of the concept of total demand chain management.

The partnership with customers is the mirror of working with suppliers with the role reversed. Ideally, the relationship will be that the customer involves the manufacturer in the market research phase so that together the best product can be designed to meet the end consumers' needs. Likewise the customer through electronic data information (EDI) or Extranet can input directly into the ERP system. Improved internal relationships within the business between manufacturing and logistics staff interfacing directly with the customers should achieve a more precise specification of customer needs and sharing data (e.g. EDI or B2C – Business to Customer web).

Thus, it is useful to carry out an activity-based costing (ABC) analysis (Pareto chart) to identify the top customers as shown in Figure 9.4. The Pareto theory is that 20 per cent of the customers will account for roughly 80 per cent of the business. ABC analysis takes this a step further by dividing customers into three groupings as shown Figure 9.4. Normally the division will be the top 5 per cent, the next 15 per cent and the balance of customers 80 per cent.

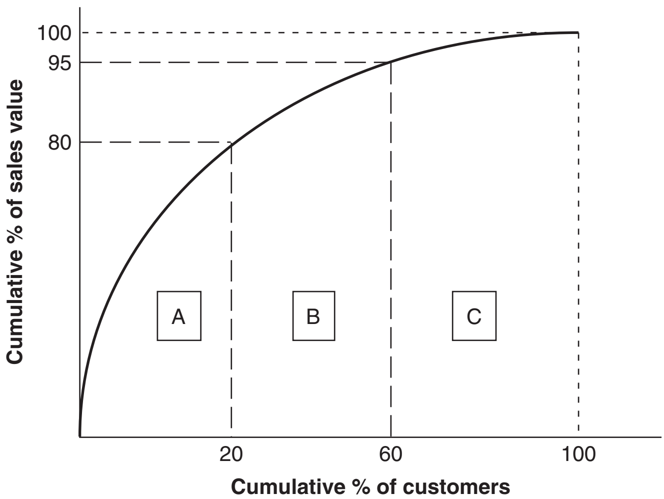

Figure 9.4 ABC analysis of customers.

In this example the analysis has been further broken down so that it can be seen that the top five customers account for 24 per cent of the sales, and overall just 3 per cent of the customers account for 80 per cent of the sales.

Another challenge of working with customers is to identify the true profitability of all customers and then to improve the profitability of key customers. Figure 9.5 illustrates that a 'tail' of unprofitable customers actually reduces the total profit contributions.

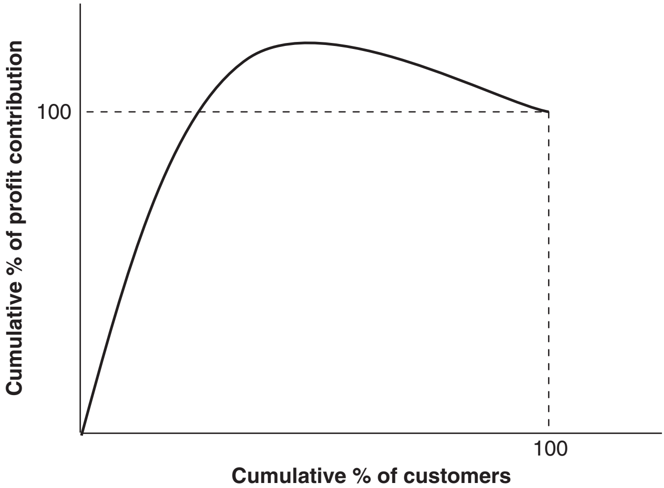

Figure 9.5 Customer profitability.
Source: Christopher (1992).

In one organization we encountered, the top 5 per cent of the customers accounted for 40 per cent of the sales, and because of their importance to the company they had been able to negotiate volume discounts and special delivery arrangements. When these benefits were examined and costed out it was found that whereas the balance of the customers were providing the company with a true 40 per cent gross profit margin on sales, these top 5 per cent were only providing the company with a margin of 10 per cent. Thus overall the gross margin on all sales for the company was reduced to 28 per cent whereas the budget had allowed for 40 per cent. This had not been apparent as the discounts had been shown in the accounts as an overhead expense and the extra transport costs had also been included as an overhead cost. There were also other reasons as to why the drop in true margin was not obvious.

In order to assess the true profitability of customers it is necessary to move away from the average allocation of cost (e.g. cost per tonne) and conventional cost accounting. Logistics managers are now working towards what is known as 'activity-based costing' (ABC) where cost is allocated according to the level of activity that consumes the resources. For example, the order picking cost of an order will vary according to its work content depending on whether the order is in full pallet or small units, number of lines or SKUs or whether it requires additional packaging.

Summary

It is generally accepted that unless you are in the distribution business you should seriously consider outsourcing your distribution to a third-party specialist. It is reasonable to expect that a specialist distribution company is likely to provide more cost effective service for a supplier. However, cost effective is not the same as service effective and it is arguable if a third-party company is likely to full customer satisfaction. When a distribution company is delivering goods on behalf of a group of suppliers it is fair to assume that the distributor will not offer any extra service beyond what is specified in service level agreements. Therefore, order fulfilment and customer relationship management will be affected by outsourced distribution policy.

In this chapter we have described the fundamentals of distribution strategy, warehouse operations, stock management, transport planning and CRM to encourage a better understanding of distribution management. With this backdrop a manager hopefully will be better equipped to manage their own distribution operations or monitor the distribution activities of third-party distributors. The knowledge of distribution management principles as a building block of total supply chain management also highlights its key role in delivering goods and services to the customer.

Part 2: Building Blocks of Supply Chain

Exercises

Forecasting

1. A popular product at Beaconsfield Garden Centre is orchid plants imported from South East Asia. These plants are nurtured in temperature and humidity controlled green houses. The monthly sales figures of orchid plants for 2006 are shown in the following table:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80	70	90	100	115	100	120	110	70	80	60	130

   (a) Forecast the monthly demand for January, February and March 2007 by using simple exponential smoothing with $\alpha = 0.1$.
   (b) Evaluate the mean absolute deviation (MAD).

2. A call centre in Bangalore recorded the incoming overseas calls as shown in the following table. This data is to be used for forecasting the staff and investment in facilities.

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006
Call minutes (millions)	35	39	44	49	56	63	73	84	96

   (a) Plot the data on a scatter diagram and develop a linear regression that best fits these data.
   (b) Is the linear regression a good forecasting tool for the call centre? How do you justify your response?
   (c) What is forecast of overseas calls in 2010?

3. The sales figures of the first 12 weeks of 2006 at Domino Pizza shop are shown below:

Week	Demand	Week	Demand	Week	Demand
1	110	5	98	9	116
2	116	6	122	10	112
3	120	7	100	11	96
4	128	8	106	12	92

(a) Estimate the forecast for the next 4 weeks using
(i) a 4-week moving average,
(ii) exponential smoothing with $\alpha = 0.1$.
(b) Evaluate the MAD and MAPE (mean absolute percentage error) for each method of forecasting.
(c) Which of the two methods do you consider more appropriate and why?

Inventory management

1. The total annual demand of an item is 2000, the ordering cost is €20 and the stock holding cost per unit per year amounts to 10 per cent of its purchase cost. The cost per unit of an item is €80.
   Find the economic order quantity (EOQ) by using the formulae:

$$\text{EOQ} = \sqrt{(2Dc_1/c_2)}$$

where D is the annual demand, c_1 is the ordering cost per lot and c_2 is the stock-holding cost per unit per year.

2. A garden centre selling sacks of fertilizer has an average demand of 10 sacks per day. The stock is replenished every 15 days.
   Assuming that for a level of 95 per cent, safety stock = 1.64 × standard deviation of demand during lead time.
   Determine the re-order level of the fertilizer when the standard deviation during 15 days is 11.6.
   (*Hint*: R = Average demand in lead time + safety stock.)

3. Ford Motor Company has an engine plant in England and a car assembly plant in Germany. The assembly plant delivers 1500 completed cars to distributors every year. Engines are transported by trucks to Germany. The transport and shipping cost for each truck is £1000. The ex-works cost of each engine is £1500 and the stockholding cost for engines in England is 20 per cent per year.
   Calculate by using EOQ formula how many engines should be transported by trucks in each trip?

4. A sports shop in Rio de Janiro sells football T-shirts to tourists at the rate of 2000 shirts per year. The ordering cost is £20 (GBP) and the holding cost per unit per year amounts to 50 per cent of its purchase cost. The purchase cost per unit of the T-shirt depends on the total quantity ordered as follows:

Less than 500	500–999	1000 or more
1.21	1.00	0.81

   (a) Find the economic lot size.
   (b) Calculate the optimum value of cost per year.

5. The weekly average demand of Nokia mobile phone handset at a high street store is 300. The demand pattern is normally distributed with a standard deviation of 200. The lead lime of supply is 2 weeks. The store monitors its inventory continuously and tries to maintain a service level target of 95 per cent.

   (a) Determine the safety stock of Nokia handsets that the store should carry.
   (b) What should be the re-order point?

Planning and scheduling

1. Joyamaya Toys is a family owned business for children leisure products. The planning office of the company is based at High Wycombe, Buckinghamshire, and the distribution of products including mail orders is carried out from a rented warehouse at Milton Keynes. The turnover of the company in 2002 was £14 million.

The weekly sales forecast of 'Game Boy' including additional confirmed orders from customers is shown in Table 1. The planning office has the following additional demand and supply data:

- Distribution demand: 10 units each in week 3 and 6
- Promotion: 15 units in week 4 and 5 units in week 5
- MPS (master production schedule) lead time is 2 weeks
- The delivery of MPS is due on week 2

(a) By taking into account additional requirement for distribution demand and promotion, complete Table 1 and calculate the demand for 'Game Boy'.
(b) By using the total demand from Table 1 as forecast demand in Table 2 also the given data for MPS, calculate 'Projected available' in Table 2.

Table 1 Total demand management

	Weeks							
	1	2	3	4	5	6	7	8
Sales forecast	30	25	20	20	20	20	25	30
Customer orders	10	5	–	–	–			5
Distribution demand						–		
Promotion								
Total								

Table 2 Demand/supply review

		Weeks							
		1	2	3	4	5	6	7	8
	Forecast demand								
	Actual demand								
On hand 50	Projected available	20							
	Available to promise								
Order quantity 70	MPS at receipt								

Normal actual demand – replace forecast
Abnormal actual demand – do not replace forecast

Warehousing

1. The Central Warehouse of a large supermarket has an annual demand of 32,000 tonnes and an average stock cover target of 8 weeks. During the holiday months of July and August the weekly demand becomes 30 per cent more than the average.

Given that the average load per pallet is 500 kg and desired utilization of pallets is 85 per cent calculate the required pallets required for the peak months. Clearly state the assumptions made.

Questions

1. What is required from forecasting in the following cases:
   (a) Stock holding for a manufacturer of FMCG (fast-moving consumer goods).
   (b) A make to order just-in-time product supplier.
   (c) A mail order firm.
2. Which method of demand planning would you recommend and why for products with a low market share and which also have seasonality of demand:
   (a) A computerized demand planning software with appropriate formulae to smooth forecast.
   (b) A process of demand forecast regularly reviewed by Marketing, Sales, Manufacturing and Logistics.
3. What is aggregate planning? Explain the type of industry or product where aggregate planning would be most appropriate. How would you apply aggregate planning in a business with high demand uncertainties?

4. What are the basic capacity planning strategies? Describe with examples and a diagram (e.g. 'decision tree') the use of each of these strategies.
5. What are the key steps of a purchasing process in a supply chain? Explain the appropriate authorization level for procuring stocked and non-stocked items.
6. Explain with examples the outsourcing strategy of an automobile manufacture. What types of suppliers would be appropriate for supplier partnerships and for SLAs (service level agreements)?
7. Describe the principles of ROL/ROQ and 'Fixed Interval' inventory management systems. Show the circumstances required for each of these systems.
8. What are the common and distinctive features between a typical manufacturing and service operation? Explain how you may apply selected manufacturing tools and processes to a service industry.
9. Should all operations be managed in the same way? Explain the 'five V's' of processes and discuss there implication in managing operations.
10. It appears to be a popular practice to outsource warehousing and distribution operation. Discuss the implication of outsourcing on customer service and for competitive advantage.

Part 3

New Demands and Trends

10

Service industries, event operations and non-profit organizations

Introduction

This chapter considers the special supply chain requirements for:

- Service industries
- Event management
- Non-profit (humanitarian) organizations

All of these operations require materials just as do any other organization, but their needs and way of working merit special consideration. In service industries the output is intangible and performance will largely be measured in qualitative terms, for example value of advice, friendly empathetic service. Each service delivery will be to some extent unique. With service industries demand is often erratic and the duration of each interaction can vary. For example, a doctor in a general practice might schedule 10 minutes per consultation, but by the end of the day patients will be waiting up to an hour for their appointment due to the doctor needing longer time than planned with some patients and the late arrival of others. In events operations each event can be planned and resources scheduled in advance with some degree of certainty. Each event is unique. If an event consists of more than one performance, each performance no matter how skilled the participants, will be unique and once the event is over can it never be exactly repeated and in many cases not at all. For example, if the television and video recording equipment fails during a cup final (be it cricket, football, rugby or darts) there is no chance of a repeat. The actual performance of the actors in an event can sometimes be measured, for example 15 young Chinese women breaking the world record for the number of people on a bicycle, but for many events performance measurement is subjective, for example can Kiri Te Kanawa still hit the high notes? In non-profit operations such as relief for flood or earthquake victims, although organizations exist and contingency plans might exist, when and where the disaster will occur cannot be known. The performance of the relief organization will be hard to judge, although some lives might have been saved more could have been done, and how much of the money donated is spent on administration or wasted and what percentage actually gets to the victims?

All of the above types of operations have several things in common; each occurrence will be unique and performance to a large extent will be judged in qualitative terms and judgement can well be uninformed and emotional. In a pure supply or manufacturing operation performance can be measured in quantitative terms; for example, how many delivered, specification met, delivery on time and cost. This chapter considers the special requirements of service, event, and non-profit organizations and shows how application of supply chain management principles will improve efficiency and effectiveness.

Service operations

In the UK 78 per cent of the work force are engaged in service industries (see www.Statistics.gov.uk.) and according to the US Bureau of the Census in the USA 80 per cent of the work force is engaged in service industries or work for the government (see www.census/gov).

In Chapter 8, we distinguished service and transport from manufacturing and supply operations with the use of system structures. We repeated Wright and Race (2004, p. 4) who say that 'A service organization exists to interact with customers and to satisfy customers' service requirements. For any service to be provided there has to be a customer'. Without the input of the customer the service cannot be provided. From the clients point of view, where in some service industries such as law and accounting time charged is calculated on 6-minute blocks (10 units per hour), the cost of the service is not cheap. Customers are becoming price conscious and thus service industries across the board are under pressure to reduce costs and at the same time to provide a accurate and fast service.

Before the service provider can provide a service they will need a supply of resources. The acquisition of tangible resources such as office space, computer/information system, electricity and water, stationery, forms and brochures, etc. are generally not a big issue and any problems associated with acquisition of these basic and direct requirements will be the same for any type of organization and need not be discussed further. Service industries rely on the intellectual capital of their people. Wages will be the biggest direct cost. Service industries in turn will require services. A big area and often neglected for savings for service industries is in the purchase of indirect goods and services. Where a service organization has several offices, some distance from each other, spending escalates, and suppliers of services to the offices become passive and complacent. For the remote office it seems to be cumbersome to be continually applying for approval for routine purchases, and generally it will not be obvious as to who is responsible for what. Further when mergers and take overs occur there is a reluctance to impose rules and regulations from the 'head' office for day to day expenses and there will be little commonality in how expenses are controlled at each remote office.

Costs can be reduced. There is no reason why service industries and clients of service industries cannot adopt supply chain management and supplier relationship management to reduce costs. One of the big savings can be made by formalising service purchasing.

Service spend by non-service companies

Fearon and Bales (1995) also cited in Lyson and Farrington (2006), found from a study of 116 large American companies, that 54 per cent of total purchasing was for services. According to the Center For Advanced Purchasing Studies (CAPS) the spend for services in some organizations is as high as '86 per cent of the total purchasing spend' also see Knowledge Storm (2006). The Institute for Supply Management (2004) from their studies find that between 30 and 70 per cent of an organizations total spend is for services. Fearon and Bales in their study also found that 70 per cent of services purchasing is made by staff not in the purchasing department. In other words staff went direct to their preferred service providers and less than 30 per cent of the expenditure was handled by purchasing staff. One of the largest and not well-controlled expenditure is in travel and entertainment. Travel might in many cases require advance approval, but the actual amount spent is not well monitored or queried. It is reported that Delta Airlines by analysing service spend was able to leverage discounts with suppliers. They had several hubs each doing their own purchasing, by centralizing purchasing in 2002, over a 3-month period, they were able to save $US 11 million on the cost of hotel rooms for staff (a saving of $44 million per annum).

The reasons why staff bypass the purchasing department are fairly obvious:

1. They think they have better expertise than the purchasing department, know what they want, and cannot be bothered with following procedures and form filling.
2. They have a personal relationship with the supplier, and prefer to communicate direct rather than through an intermediary.

The dangers of allowing staff, no matter how well intentioned and honest they may be, to do their own thing is obvious. A study by Denali Consulting found that when cost savings are pursued, savings on services ranged from 10 to 29 per cent compared to an average of 5–17 per cent for other commodities or materials (Stratford and Tiura, 2003).

Once an organization realizes the amount actually spent on services the next step is to determine:

- What and why
- Where and why
- When and why then
- Who and why that person

The objective being to determine 'How'. 'How' being to agree the most efficient and effective system. It goes without saying that the new system has to be monitored to be kept in place. It is too much of a temptation for staff in a hurry to bypass the system.

Outsourcing

Purchasing departments if not accustomed to buying services almost certainly will need to develop new skills. A study by CAPS (2003) found that 75 per cent of the respondents (from purchasing departments) found it was more difficult to manage (and buy) services than to buy/manage goods. If an organization does not have the right purchasing staff, outsourcing of specialist purchasing should be considered.

It is becoming increasingly cost effective for organizations to outsource service provision. For example, in 1999 Harley-Davidson outsourced its entire indirect spend to three suppliers, who either provide the service required or who in turn arrange services from other suppliers. The savings in 2000 amounted to a reported $US 4 million.

Service providers can be grouped under the following headings:

Professional	Personnel	Property	Support
Legal Financial Taxation Consultants (such as Six Sigma) Medical Insurance Architects Specialist research Travel arrangements	Recruitment Appraisals Staff contracts Pay roll Development/training Welfare/counselling Labour/union relations	Cleaning Maintenance Additions Layout planning Waste management Environmental advice Recycling Gardens Security Reception	Information technology Logistics Procurement Printing and copying Vehicle fleet Laundry Catering Credit control

ISS, a Danish based company operating in 42 countries with a staff of 375,000 provides ‘facility’ services with specialist divisions for cleaning, office support, property and catering. Other companies provide specialist services for one or more of those listed above.

It can be argued that an organization, large or small, will find it more efficient, effective and cheaper to subcontract to specialist organizations and to concentrate on their core business. Whereas once large organizations such as hospital and military bases would have own support services of kitchen, laundry and do its own cleaning, all of these activities are now subcontracted. Likewise, for a small or medium enterprise having own in-house lawyer or other professional specialist would not be warranted.

The public sector and government organizations are engaged in initiatives to improve the performance of their service supply chain and reaching out to the experience of global service providers such UPS, FedEx and DHL. The national institution of National Health Service (NHS) in the UK which is known to be an icon of self-contained healthcare services has formed an outsourcing service supply chain partnership with DHL Logistics.

Case example: DHL service supply chain for NHS

In 2006, DHL Logistics won a 10-year deal to manage GBP 22 billion of the UK Department of Health's annual procurement spending. Under the agreement, DHL will run a division called NHS Supply Chain on behalf of NHS Business Services Authority, and be responsible for delivering all procurement and logistics services across an initial 500,000 products to support 600 hospitals and other healthcare providers in England. NHS Supply Chain will have its own management team and be governed by a Board dedicated to managing the performance of the operations. The range of products NHS Supply Chain will manage encompasses a range of goods including supplier and maintenance contracts, food, bed linen, office equipment, stationery, cleaning products, patient clothing, medical and surgical equipment, dressings and provisions. The UK Department of Health believes the arrangement will allow public health authorities more resources to patient care and continue to manage their cost base.

DHL has committed to return GBP 1 billion savings over the contract period back to the UK National Health Service. John Allan, Chief Executive of DHL's Logistics division, said, 'The contract will ensure that NHS Trusts get access to a wide range of high quality, innovative products that will be selected by having extensive dialogue and testing procedures with clinicians'.

Logistics Today (September 2006)

Event management

The events industry includes festivals, meetings, conferences, exhibitions, ports and a range of other events. With the growth of government regulation and corporate involvement in events including sponsorship, the event environment has become increasingly complex. Event managers are required to understand the needs of their direct customer and of the final customers and to satisfy a number of stakeholders. The number of suppliers including performers can be complex. And in some cases the event manager will have no direct control, but will be held responsible if things go wrong.

The following section is derived, with amendments from Tum et al. (2005).

Resources and specializations used for each event are diverse, and can be sourced from many different suppliers. Some of the resources may be under the events manager's direct control, and others may be subcontracted or outsourced to agreed specialists – for example, lighting and sound contractors, caterers, musicians and pyrotechnic companies.

The event supply chain can be shown as Figure 10.1.

Supplier→

Supplier→ Event manager←→Client←→Customer

Supplier→

Figure 10.1 Event supply chain.

Managing this chain will normally involve dealing directly with purchasing and supply and inventory management. The feedback that flows backwards is essential because it allows the event manager to see how well received the products, supplies and services were, and whether there should be any changes in the future.

The flow of resources should be managed from its very origins right up to the point where the customer experiences the event. For example, the event manager needs to know the health and safety procedures for a visiting Chinese circus company including a firework display to coincide with the Chinese New Year at a local football ground booked though an agent. Although the agent will have covered many of the details, the event manager will still need to be assured about the suitability of the performance, how it will match the needs of the audience, and how it can be coordinated with all the other activities into a whole event.

For an event there can be many different supply chains through which the varied resources flow. They all have to be managed and coordinated into one event, which is delivered at the moment it is experienced.

Supply chain management is a holistic approach that stretches forward across the event manager's own organization to the client and customers (see Figure 10.1), and backwards through the many different suppliers and to their suppliers. By having this holistic approach and integration across company boundaries there can be substantial benefits for all stakeholders. It should be viewed as a chain, and any break in that chain will have an adverse affect on the client. The aim is to develop an integrated supply chain to achieve those critical success factors judged by the customers, required by the client and other stakeholders including local regulatory authorities. Unlike most other industries, the project that the event manager is responsible for cannot fail. It must happen on time, and there is no chance of a repeat. For example a one night concert cannot be repeated if the hall has been double booked. If on the night, 10 minutes after the start the lighting system or sound system fails for a rock concert the event manager will not be able to arrange another supplier.

Basic objectives of purchasing

Like any other manager event managers are responsible for providing events at the right cost, the right time, to the right specification and quality, and for the right duration. These requirements are made even more challenging when many of the resources are arranged through third and fourth parties. As for any operation the event manager will be under pressure to keep costs down.

Often within an event company there is not a specific purchasing officer, and many of the staff may create buyer/supply relationships with different companies. Some products may be bought outright and owned by the organization, and others will be used for only one event. In the case of some of the purchase agreements, for example, the caterers or security service, it is the whole service and system that is purchased and the contracted company will bring their own resources and staff. To be successful, these relationships and the method of purchasing or leasing must be managed effectively since they all provide vital supply chains throughout the operation.

In arranging contracts the events manager must always take time to check legal implications and to assess what can go wrong and what the implications will be. Risk management is crucial.

The companies from whom products and services are purchased should not be just seen as suppliers, but should be considered as customers. They are customers in the way they are approached for quotations. All businesses are both customers for some other business. Every operation and part of an operation should be seen as a network, linking together customers' customers and suppliers' suppliers. In the event industry many of the suppliers are specialists and have their own marketplace and rules and regulations that have to be conformed to. This includes health and safety, government agencies, international companies and international customers, and many other organizations. The event manager needs to be able to stand back and see the myriad of operations and contracts, working together to deliver the event, as a whole and integrated network of supply chains.

Slack and Lewis (2002) point out that there are qualitative issues to understand:

1. How does an operation relate to other players in its network?
2. What knowledge of its supply network does it have? Is it close and intimate?
3. Does its supply network have an intimate and close understanding of its own operations, and ultimately its customers' needs and objectives?

Single sourcing or multi-sourcing of suppliers?

The event manager should question the number of suppliers with whom the organization is involved. Does one supplier provide a 'one-stop shop' where many of the resources required can be purchased, or are there are a great many suppliers providing a range of different services for the same event? If the latter is the case, then there are consequently more supply chains to be managed. Often in events management many brief relationships will be made and there will not be time to develop loyalty, trust, and understanding of each other's needs. In reality, depending upon the type of event, a combination of the two polices would be used.

For example, if you produced classical concerts nationwide you could use a UK wide sound and lighting company that produces bespoke requirements for each event, including design and set-building, but you would most likely use a local caterer and security company. Silver (2004) recommends that all projects or purchases should be put out to three bids every time to ensure competitive pricing. On the other hand, Tum et al. argues that a company that is assured of continued business with an organization will provide competitive prices. It avoids quotation and administrative costs, and will know which staff and resources are necessary for the provision of the service. This close relationship might be jeopardized if frequent competitive tendering is undertaken. However, complacency within this special relationship must not be allowed to propagate and lead to decreased customer satisfaction or over pricing.

Some event companies prefer to complete everything in-house – both important and non-important activities. This style of company is known as being vertically integrated that is, it creates and supplies all the necessary resources and services from within its own resources. An example of a vertically integrated company is a circus owner who owns the circus animals; has the artists on payroll; owns the big top, other tents, caravans and transporters; employs his own costume makers, scene designers and constructors; has a supply of memorabilia for sale; runs a refreshment booth; and does his own promotion. At the other end of the scale some event companies do nothing in-house and buy in all of their requirements. This style of company is referred to as being virtual. An example of a virtual company is a promoter who arranges the tour of an overseas ballet troupe, hires the theatres, arranges accommodation for the artists, hires the orchestra, etc., and uses an advertising agency for promotion. In essence, the promoter owns nothing and works from a rented office. However, the event manager in this case cannot subcontract the risk or the responsibility!

Vertically integrated organizations

Making a choice to buy out a supplier, or to make/provide those products and services in-house, would be known as backwards integration. In the event industry that might entail buying out a lighting specialist or a catering company, or making all the props for themed evenings in-house rather than using an external company. This may be worthwhile if that specialism is being used a great deal within all events, and if the cost of acquisition and integration into the company would create savings and increase a better provision of what is needed. Other advantages include preventing competitors from gaining control of key suppliers.

Forward integration is when an organization buys out or actively completes the work done by a customer. In the event industry, an example might be a lighting or catering company which, instead of always waiting for an event company coming to them to ask for a quotation to supply certain goods and services for an event, proactively seeks out customers and puts on the event itself.

As covered in Chapter 12 the Internet and e-mail provides quicker response and quicker access to information. The Internet also opens up a greater choice of providers.

The integrated flow of materials and services through and from the operation is a prerequisite for achieving high-quality, rapid and low-cost provision for clients. Therefore, managing the supply chain is a major concern and of major importance for event organizations, where a high proportion of their products and services often come from different suppliers or different parts of the organization.

In delivering this well-managed supply chain, the aim of the event company should be to diminish obstacles between functions and departments within the organization, minimize activities undertaken, and improve the links between the departments so that there is no unnecessary repetition. External to the organization, the event manager should look to improve communication and relationships with suppliers.

O'Toole and Mikolaitis (2002) see the contract as central to the correct procedure for project planning and implementation. Much is written about contracts in engineering, building and software industries, and event manager can take advantage of lessons learned from successes and failures in these other industries in their use of project management. Each contract specifies who will do what, when and how. It can contain many details, or be simple letter of agreement or a purchase order.

Decision points in purchasing for an event organization

Although each event is unique, the following nine-stage purchasing chain of decisions is provided as a check list to enable the event manager to assist in planning. Stage 9 is important as it enables the event manager and future event managers to benefit from past experience:

1. When it is initially considered that an event should go ahead, there is a need for a range of products and services. There should be detailed discussion regarding how these might best be procured – in-house or from an external company.
2. The next stage is to create a clear specification of what is required.
3. Some organizations may have a list of preferred suppliers. This provides useful contacts regarding reliable companies who are known to deliver as per specification of quality and who also respect and value working with the event manager's organization.
4. Suppliers should be approached for a price and an overview of what they could provide – Can the exact specification be provided? Is there flexibility of provision?

5. When the quotations are returned, it is important that they are examined fairly and checked to see that what is being offered is as per specification.
6. The price and quality and reliability may be compared against in-house provision where that is possible. If you buy on price alone, you will get what you pay for. Cheap can be expensive!!
7. When the event manager is satisfied that the goods and services are as required in all respects, including competitive price and appropriate provision, then an agreement can be made with the supplier. This may be called a purchase order, but in reality what happens is that a contractual relationship is formed between the event manager and the supplier. A contract is said to exist when something is offered and accepted in writing or verbally with witnesses. Its purpose and provisions must be legal, and the different parties should be capable of entering into the agreement. The standard contract elements, according to Catherwood and Van Kirk (1992), are:

   - Specification of the agreeing parties
   - Purpose of the contract
   - Duration of the contract
   - Terms
   - Signatures
   - Witnesses and date signed

8. The goods and services should be delivered as expected. In many instances within the events industry the actual delivery and consumption will be simultaneous. For example, a rock band delivers its services at the moment it is playing for the audience.
9. The final stage is a review. Did the purchased product or service deliver as expected and as required? The review will inform the next set of decisions about a similar service/product. Review after the event, when successes and problems are still fresh in the mind, is essential. Consider and note what went right, what went wrong and what would we do differently next time? It is advisable to record contact names and addresses on file for future reference. Each event should be better managed than the last one. There is always room for improvement. Event managers should ask staff and subcontractors what they think could be done better, and their opinions should be taken seriously.

Customer relationship management

Customer relationship management (CRM) software now exists to capture data to improve overall supply chain performance (also see Chapter 9). The objective of CRM is to develop a customer-centred organization that ensures every opportunity is taken to delight the customers, foster customer loyalty, and build long-term relationships that are mutually beneficial. The ultimate gain is to ensure that each customer's current and future wants and needs are satisfied.

This involves recording details of each time we work with a customer, and developing a picture from this information of what the customer liked and did not like in our past dealings. Although software exists to capture these data, for smaller operations such information can easily be recorded as notes on the customer's file.

Non-profit (humanitarian) organizations

Unlike events management, natural disasters do not keep to a timetable. None the less as a disaster will require quick response delivery of materials and services, an efficient supply chain would seem to be important. From a study of the literature and media reports it is found that the general perception is that money is not spent wisely, and overall performance of relief agencies be they government funded or private are generally not as efficient as they could be or should be.

From a survey of 54 organizations, Oliver (2006) found that non-profit organizations compared to commercial organizations:

1. Have fewer regular meetings with key suppliers, do not easily engage in collaborative product development, have little direct information technology (IT) interface and seldom have a designated body responsible for co-ordination.
2. Have less trust in their supply partners, but ironically were less likely to monitor the performance of their suppliers. Where there is some distrust the implication is that the suppliers should be checked. He also quoted Kupila (2003) who believes that suppliers to the humanitarian agencies were less approachable and proactive. Kupila also observed that donors to charities do not fully trust front line agencies.
3. Have less control over their logistics network, with inbound and outbound logistics comparatively less efficient. Oliver found that the humanitarian organizations have less power within the supply chain. He contends that co-operation in a supply chain can be achieved through power or by a strong drive to meet common goals, and that generally both these factors were missing. He also found that single sourcing was not prevalent and in his opinion and from our experience single sourcing leads to tighter control and a better understanding of common goals. Oliver found that weakness in power and control leads to deficiencies in management of incoming goods and services and insufficient cost information and control.
4. Supply chain professionals in the humanitarian organizations are undervalued and are less likely to be encouraged to develop and to be involved in key decisions.
5. Charities do not use IT effectively in the supply chain. This hampers performance in knowledge sharing, demand planning, collaboration and performance monitoring. End to end costs are not always clearly known.
6. Performance is not well assessed and therefore continuous improvement suffers.

Case example: Wal-Mart

Referring to the Hurricane Katrina disaster in New Orleans, Waller (2005) was not surprised that Wal-Mart responded quicker and was more effective in providing what was required than the Federal Emergency Management Agency and the Red Cross. As he said Wal-Mart was only doing what it does every day. It has mastered Supply Chain Management and the company's expertise worked well during the disaster.

Worthen (2005) provides an insight as to how Wal-Mart was able to perform so well. 'The hurricanes that flattened the Gulf Coast in August and September tested corporate logistics and supply chain operations, as companies struggled to move relief supplies and inventory to and from the region before and after each storm.' Wal-Mart trucks were distributing aid to Katrina's victims days before federal relief arrived. One lesson from these storms is that having procedures for communicating quickly about what needs to be done is as essential for companies as having integrated inventory and logistics systems. 'Wal-Mart, for example, was able to move food, water, generators and other goods to areas hit by Hurricanes Katrina and Rita following each storm because it has an emergency operations center that is staffed every day around the clock by decision-makers who have access to all of the company's systems. Under normal circumstances, a 6 to 10 person staff at the center responds to everyday emergencies, such as a fire in a store or a shooting outside one. When disasters such as hurricanes threaten, the staff is joined by senior representatives from each of the companies functional teams. The center is equipped with hurricane-tracking software, and on August 24, days before Katrina made landfall, company managers were already planning their response.'

The emergency response team works in a large, open room that is designed with efficient communication in mind. For the record during the first two and a half weeks following Katrina, Wal-Mart shipped 2500 containers to the region. Wal-Mart also set up satellite links for its stores that lost phone or Internet service so that they could stay connected to headquarters.

Worthen reported that Starbucks was also able to get aid to hurricane-ravaged areas quickly. 'When the company got a request from the American Red Cross to donate coffee, managers at headquarters contacted the company's distributors to discuss how they could help. Starbucks determined that it could donate 30,000 pounds of coffee, 235,000 bottles of water and 44,000 pastries without affecting supplies to its retail stores'.

Adapted from Waller (2005) and Worthen (2005)

Summary

The economies of most advanced countries are heavily dependent on service industries and today's progressive business leaders are dramatically reshaping their enterprises extending their reach through partners, resellers and e-commerce. This chapter has looked at the special circumstances that face managers of service industries, events and non-profit humanitarian organizations.

In service industries it is found that service spend is less controlled than for direct goods and materials and that in service industries the expenditure on services is a comparatively large and generally not well-controlled expense. The same applies to all other types of organization, the spend on services is not treated as seriously as is the expenditure on goods and materials. Centralizing all purchasing of services under the control of the purchasing department is one approach. The other is to outsource the purchasing of specialist services. The example given was Harley-Davidson who saved $US 4 million per annum by subcontracting service spend to three suppliers.

With events management it was shown that seldom there is a second chance. Once an event has been staged it cannot be recaptured. Thus, events managers have to get it right first time. The various methods of supply chain management practiced by events managers were considered including subcontracting. Although each event is unique, a nine-stage purchasing chain of decisions was provided as a checklist to enable the event manager to get it right first time and to benefit from past experience.

For non-profit humanitarian organizations it was found that greater adoption of supply chain management principles will improve performance. A major issue being the need to have agreements with suppliers and procedures for communication in place before any disaster occurs. Unlike event management the timing of a natural disaster cannot be known, but as shown in the Wal-Mart case study it is possible to have resources in place and on standby to meet emergencies when they occur.

11

Supply chain in emerging markets

Introduction

'The Empire strikes back: India forges new steel alliance. It is a dramatic illustration of the shift in the balance of power from West to East: a £5 billion bid for Corus, formerly British Steel, by Tata, an industrial conglomerate that has aspirations to turn itself into an Asian version of America's General Electric', writes *The Observer*, the Sunday paper in the UK, on 22 October 2006. Founded by Jamsedji Tata in the 1860s, initially with a textile mill in Bombay (Mumbai), is today India's largest company with a controlling interest in 96 companies. In 2000 the Tata group became the first Indian company to gain a major international brand when it acquired the UK company Tetley Tea. Tata is one of the world's lowest cost producers of steel; Tata Chemicals is one of the Asia's largest manufacturers of soda ash; Titan is one of the world's top six manufacturers–brands in the watch sector and Tata Motors is among the top six commercial vehicle manufacturer in the world. Besides being the largest software services provider in India it is also India's largest international long distance telecom and Internet services provider.

Tata is not the only organization from the emerging market that is making the world sit-up and notice. Khanna and Palepu (2006) cites a list of companies from emerging economies who are competing in the global market, for instance, Brazil's AmBev (which in 2004 merged with Belgium's Interbrew to form InBev); Chile's S.A.C.I. Falabella; China's Baosteel, Galanz , Haier and Lenovo groups and Huawei Technologies; India's Dr Reddy's Laboratories, Infosys, NIIT, Ranbaxy, Satyam, Mahindra and Mahindra and Wipro; Israel's Teva Pharmaceuticals; Mexico's Cemex; the Philippines' Jollibee Foods and Ayala groups; Turkey's Koc and Dogus groups; and South Africa's SAB Miller.

The multinationals from North America, Western Europe, Japan and Korea appear to have near-unbeatable advantages over companies from emerging economies, such as well established brand names, large R&D infrastructure, proven management systems, advanced technologies and access to a vast fund of both financial and intellectual capital. However after a closer analysis it is evident that the newly industrialized countries can benefit from the experience of advanced economies and adapt the best practices to their local advantage. Historically Japan and later Korea did just this in the 20th century. It is like the saying, 'an early bird catches the worm but the second mouse gets the cheese'. Furthermore the companies in emerging markets can count on their supply chain partners to make and deliver products more inexpensively and can work better around the local bureaucratic processes. We shall analyse these factors in this chapter.

China is the fastest growing market in the planet. Since the start of liberalization in 1979, the countries GDP is growing at 9.3 per cent annually – three times faster than United States. With a combined population of 2.5 billion, China and India have the most consumers in the world. Besides China and India, over the past two decades waves of liberalization have swept aside protectionist barriers in developing countries in other regions such as Latin America (Mexico, Brazil, Chile and Argentina), South East Asia (Malaysia, Thailand, the Philippines and Indonesia) and Eastern Europe (Poland, Czech Republic and Hungary) and Africa/Middle East (Turkey, Israel, South Africa and Egypt). As these nations adapted themselves and interface with the global economy, multinational corporations from the advanced economies of North America, Western Europe, Australasia, North Korea and Singapore expanded their outsourcing and supply chain network. In this chapter we focus especially on three regions of emerging markets:

- Supply chain in India
- Supply chain in China
- Supply chain in Latin America

Supply chain in India

Economics experts and various studies envisage that India and China will dominate the world during the 21st century. For over a century the United States has been the largest economy in the world but major developments have taken place in the world economy leading to the shift of focus from the USA, the rich countries of Europe, and the eastern dragons of Japan and Korea to the two Asian giants – India and China. Experts predict that by 2035, India is likely to be a larger growth driver than the six largest countries in the EU, though its impact will be a little over half that of the USA. India, which is now the fifth largest economy in terms of purchasing power parity, will overtake Japan and become third major economic power within 10 years. The visible success factors are the liberalization of a 1.2 billion consumer market, a good higher education policy supplemented by European and American training and English speaking communication and management systems.

India is however still a country of visible contrasts. The sophisticated nuclear science technology in research centres contrasts with bullock carts in rural areas. Indeed in Bangalore (population 6.2 million), regarded as the IT (Information Technology) centre of India, bullock carts can still be seen. In the past few years the cities in India have undergone tremendous infrastructure up grading but the situation is not similar in most part of rural India. Universities are producing millions of English speaking graduates in science, medicine and engineering, yet in the realm of health and primary education and other human development indicators India's performance has been far from satisfactory, showing a wide range of regional inequalities with urban areas getting most of the benefits. Although Indian Railway network employs a vast army of employees with moderate effectiveness the infrastructure of road network and port handling facilities have a long way to go.

In spite of the above challenges, the economic growth in India in the early 21st century has been remarkable. The growth in Indian industrial sector in 2004–2005 remained healthy. The index of industrial production (IIP) continues to grow at the rate of 7 per cent. The major element of the buoyancy in the industrial growth was the manufacturing sector with 80 per cent of IIP. Service sector accounts more than half of India's Gross Domestic Products. The growth rate of India's service exports in 2005 was 8 per cent with regards to 5 per cent worldwide. Reason for high growth rate in service sector in India is liberalization in regulatory framework and high demand for low cost IT, BPO (business process outsourcing) and call centre services. India's IT Market reached a turn over of US $16.2 billion in 2004–2005. The IT sector employs 697,000 people and this is likely to reach 2 million by 2014. The BPO and call centre sector has been growing at 60–70 per cent annually and its turnover in 2004–2005 reached US $5.8 billion.

In congruence with the diverse infrastructure, level of technology and economic development the supply chain and logistics models in India are also diverse. For example, the auto industry follows a traditional model of the West and Japan for a predominantly urban and affluent market. At the other end of the scale fresh foods supply are limited to the regional markets. Manufacturers of fast-moving consumer goods, such as Hindustan Lever, deploys a hybrid of urban and rural logistics by empowering the regional wholesalers for stocking, distributing branded products to rural customers. Multinational retailers, such McDonald's restaurant chain, are gradually applying the available local infrastructure to the best of their advantage. The following case examples illustrate the application of appropriate supply chain models in India.

Case example: The auto components supply chain in India

The most highly developed supply chain in India is that of the automobile industry and over the past decade Indian companies have begun to play a major role in its extension. The liberalization of the local equity and regulatory control encouraged the arrival of a wave of international car makers as joint ventures with local partners.

A link up with Suzuki, forming Suzuki–Maruti company (now Maruti Udyog) led to early success. The once dominant Hindustan Motors whose 'Ambassador' model had India's biggest selling cars in a controlled market for decades lost market share to the new Suzuki–Maruti model in an open market. Suzuki–Maruti went on to capture over 60 per cent of passenger car sales by 2002 as shown in Table 11.1.

Table 11.1 Car makers in India 2002

Maruti Udyog Ltd.	62%
Hyundai Motor India Ltd.	17%
Tata Engineering and Locomotive Co. Ltd.	12%
Hindustan Motors Ltd.	4%
Others	5%

The development of the auto industry supply chain in India proceeded very rapidly at the level of car makers and their first tier suppliers. Here current standards are close to world class standards and it has led to exports of components and sub assemblies to overseas car makers. Furthermore domestic car makers like Mahindra and Mahindra can outsource more effectively achieving cost reductions while maintaining quality levels. Another strategic choice in a low wage environment is the use of highly qualified employees for shop floor operations. For example, one car seat maker employs only science graduates for all production line operations. The car producers interact very closely with low technology components such as car seats and exhausts.

The main weakness of the supply chain lies in the fact that in spite of the effective collaboration between car makers and first tier suppliers international best practices are not permeating down to the second or third tier suppliers.

Source: J Sutton, London School of Economics (2004)

Case example: Seafood supply chain in India

Sustainability of fish stock is a global concern. According to the Food and Agriculture Organization (2002) about 47 per cent of main fishing stock are over exploited and are very close to their sustainable limits. Several measures are being adopted at national and international levels, including India, to promote sustainable fisheries. With an annual fish production of approximately 6 million tonnes in 2003, India ranks fourth in global fish production. The seafood world market has doubled in the last decade reaching approximately $50 billion and India’s share of export to the world seafood market is nearly 3 per cent. Chennai, Kerala, Mumbai and Visakhapatnam are the four biggest seafood exporting ports in India accounting for about two-thirds of the total seafood exports.

Most exports are in the form of frozen fish and more than 60 per cent of India’s seafood exports to south-east Asia are re-exported after processing. Fish is a depleting commodity and regulations on excess fishing have made supply conditions more irregular. In India state governments are responsible for the development and sustainability of the fishery sector, but their inability to form a cartel (similar to the oil cartel) seafood exporters are unable to charge higher prices in spite of rising costs of fuel and maintenance. Fishing efforts are largely (about 90 per cent) are confined to the inshore waters within a depth range up to 70 meters.

There are generally two types of fish landing centres. They are natural ports which are normally beach landings and constructed ports. Each has distinct infrastructure problems.

The seafood supply chain in India, in general comprises Fisherman to Commission Agent to Supplier (pre-processor) to the Exporter.

The average share of the final export price is typically as follows:

Fisherman	25%
Commission Agent	15%
Supplier	20%
Exporter	40%

Transaction costs between the Fisherman and Commission Agent are borne by the Agent and those between the Agent and the Supplier are borne by the Supplier. However those between the Supplier and Exporter are borne by the Supplier.

The Fisherman sells his catch to the Commission Agent who is the link between the Fisherman and the Supplier. The Commission Agent is useful because he deals with less literate Fishermen as well as organized Suppliers. The Supplier has trucks to transport to his facility where stocks are cleaned and graded based on size and quality. The Exporter is the price setter and the most sophisticated end of the supply chain. Issues such as HACCP (Hazard Analysis and Critical Control Point) first emerge at the Exporter's end. The rest of the downstream supply chain is vaguely aware or completely unaware of export–import and safety issues. Fishermen are the most disorganized group in the supply chain. They are spread across the country, practice different fishing methods and operate on different scale but they are the most affected stakeholder of government regulations of fishing bans and conservations.

Although the seafood supply chain is organized and well connected with adequate clusters and sophisticated exporters, fishermen and bottom of the chain workers are not trained in fish hygiene, safety and handling methods and not adequately rewarded. The beach landing ports and most constructed ports are also inadequately equipped.

Source: Kulkarni (2005)

Case example: McDonald's India supply chain

McDonald's Corporation (USA) opened its doors in India in October 1996. McDonald's in India is a 50-50 joint venture partnership between two Indian businessmen. Amit Jatia's company Hardcastle Restaurants Pvt. Ltd. owns and operates McDonald's restaurants in Western India. While Connaught Plaza Restaurants Pvt. Ltd. headed by Vikram Bakshi owns and operates the Northern operations. Ever since then restaurants opened in Mumbai, Delhi, Pune, Ahmedabad, Vadodara, Ludhiana, Jaipur, Faridabad, Doraha, Manesar, Bangalore and Gurgaon, and more are in the pipeline.

McDonald's India has developed a special menu with vegetarian selections to suit Indian tastes and preferences. McDonald's does not offer any beef or pork items in India. The company established what is known as 'cold supply chain'. The term Cold Chain describes the network for the procurement, warehousing, transportation and retailing of food products under controlled temperatures. McDonald's restaurants store products to be used on a daily basis, within a temperature range of –18°C to 4°C. About 52 per cent of our food products need to be stored under these conditions before they are used.

All suppliers adhere to Indian government regulations on food, health and hygiene while continuously maintaining McDonald's recognized standards. As the ingredients move from farms to processing plants to the restaurant, McDonald's Quality Inspection Programme (QIP) carries out quality checks and HACCP at over 20 different points in the 'Cold Chain' system. Setting up of the Cold Chain has also enabled the company to cut down on operational wastage.

The relationship between McDonald's and its Indian suppliers is mutually beneficial. As McDonald's expands in India, the supplier gets the opportunity to expand his business, have access to the latest in food technology, exposure to advanced agricultural practices and the ability to grow or to export.

There are many cases of local suppliers operating out of small towns who have benefited from their association with McDonald's India. For example, the implementation of advanced agricultural practices has enabled Trikaya to successfully grow speciality crops like iceberg lettuce, special herbs and many oriental vegetables. Vista Processed Foods Pvt. Ltd. is a joint venture with OSI Industries Inc., USA; McDonald's India Pvt. Ltd. and Vista Processed Foods Pvt. Ltd. produces a range of frozen chicken and vegetable foods. Dynamix has brought immense benefits to farmers in Baramati, Maharashtra by setting up a network of milk collection centres equipped with bulk coolers. Amrit Food, an ISO 9000 company, manufactures widely popular brands – Gagan Milk and Nandan Ghee at its factory at Ghaziabad, Uttar Pradesh. An integral part of the Radhakrishna Group, Foodland specializes in handling large volumes providing the entire range of services including procurement, quality inspection, storage, inventory management, deliveries, data collection, recording and reporting.

Source: www.mcdonaldsindia.com (2007)

Case example: Rural supply chain at Hindustan Lever Limited

By 2005, Hindustan Lever Limited (HLL), a subsidiary of Unilever Group was one of the India's largest fast-moving consumer goods companies with market leadership in home and personal care products and one of its seven biggest exporters. HLL operated over 100 manufacturing facilities across the country, together with several third-party manufacturing arrangements.

HLL's potential distribution outreach in India was 3800 towns and 627,000 villages. However, of the total number of villages, the existing distribution network only reached 300,000. HLL's dilemma was how to extend it into the remaining villages in inaccessible rural areas.

HLL already had one of the widest and most efficient distribution networks for consumer products in India; in fact, this was recognized as one of its key strengths. HLL's products were distributed through a network of about 7500 'redistribution stockists' (RS) who sold to shops in urban areas and villages with more than 2000 people that could be reached by vehicle. Its supply chain was supported by a satellite-based communication system, the first of its kind in the fast-moving consumer goods industry. This sophisticated network with its voice and data communication facilities linked more than 200 locations all over the country, including the head office, branch offices, factories, depots and the key 'RS'. This was a tried and tested model.

However, HLL wanted to penetrate these local communities even further and work deep within the villages. A profound knowledge of Indian rural communities would give HLL an unbeatable market advantage. However, the only solution for many Indians below the poverty line was to borrow from a moneylender at extortionate rates. A solution had been found to counteract the power of the moneylender in rural Indian areas. The successful Grameen Bank initiative, launched in Bangladesh in 1976, had more than proved that commercial banking for the poor without collateral was not a pipe dream and was awarded Nobel Prize for Peace in 2006.

HLL's growth strategy was to ask 'self-help groups' (SHGs) to operate as 'rural direct-to-home' teams of saleswomen, who would accomplish several tasks by raising awareness and educating people about HLL products as well as selling the products directly within their communities.

The idea was for the women to not only act as salespeople, but also as veritable brand promoters, often physically demonstrating products, such as shampoo, by offering hair washes at religious festivals, at the local village markets (*haat*) or by performing hand washing experiments.

A pilot initiative was set up in the Nalgonda district of Andhra Pradesh in November 2000, with 50 SHGs in 50 villages and the participation of 1000 to 2000 inhabitants. Once fine-tuned, the model would be scaled upward to cover more than 150,000 villages in India. This HLL-SHG business partnership initiative was called 'Project Shakti', meaning 'strength' or 'power'. By the beginning of 2002, the project team had already reached the entire Nalgonda District and exceeded 400 villages with no signs of this momentum slowing down (refer to Figure 11.1 for an illustration of HLL's rural distribution model).

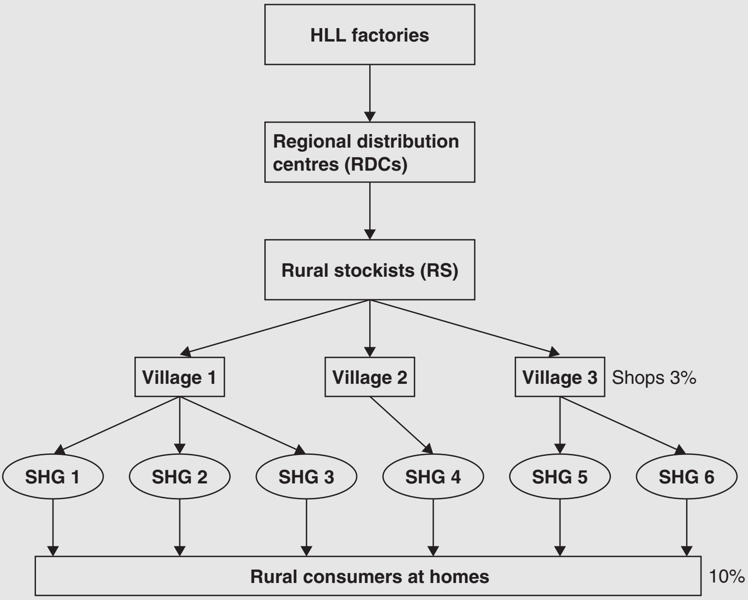

Figure 11.1 Rural supply chain model at Hindustan Lever Ltd.

Source: Amann and Ionescu-Somers, Henley Management College (2006)

Supply chain in China

During the past 3 years (2003–2005) China has accounted for one-third of global economic growth (measured at purchasing-power parity), twice as much as America. In 2005, China became the world's 4th largest economy replacing

Britain. In 2006, China's official GDP growth rate has surged to 10 per cent. Even this may underestimate the true rate, which some economists reckon was as high as 13 per cent. In 2003 alone, 'it consumed 40 per cent of the world's output of cement. It also accounted for one-third of the growth in global oil consumption, 90 per cent of the growth in world steel demand, and more than the whole of the increase in copper demand' according to the Economist, 13 May 2004. It is predicted (Lieberthal et al, 2003) that for the next 10 years, and probably considerably longer, multinationals should be the biggest winners as China's economy becomes increasingly open.

In addition to its phenomenal economic growth China offers a powerful combination to sustain this growth including a disciplined, low cost labour force, a large pool of technical personnel (e.g. China graduated over 2 million engineers and technicians in 2004), tax incentives to attract investment and infrastructure sufficient to support efficient manufacturing operations and exports. Like its export base, China's home market is also growing spectacularly. For example, 6 million mobile phone subscribers are signing up every month. Comparable growth is also seen in the use of computers, motor cars and retail stores.

China also has major challenges. The coal-fired power stations and emissions from cars and from industrial and domestic facilities are causes of serious concern for the environment of the planet. A lack of management expertise plus a culture of a centralized economy is also a major constraint on the competitiveness of Chinese companies. However, after two decades of joint ventures and management training Chinese managers are developing skills in critical multi-functional management tasks. Nonetheless in 2003 during the outbreak of SARS (Severe Acute Respiratory Syndrome) despite extensive investment in genomics Chinese research institutes waited for specific orders from higher government levels before turning to SARS research and this inertia due to centralized control and beaurocracy is still a concern. China's transportation, distribution and retail infrastructures are still being developed, and it is expensive to supply goods nationwide. Furthermore, provincial governments impose taxes on goods that are not manufactured in the region. Zeng and Williamson (2007) commenting on the backdrop described above of economic growth and local strengths and weaknesses, accordingly identified four groups of Chinese companies tackling the global markets. China's 'national champions' (such as Haier Group, Huawei Technologies, Legend Group and Wanxiang Group) are using their advantages as domestic leaders to build global brands (see Haier Group case example). The second group is the country's dedicated exporters (such as Galanz, China International Marine Containers and BYD Battery) who are entering the export markets on the strength of large economies of scale. Another group, 'competitive networks' (such as Wenzhou, Chenghai & Shenzhen and Schenzen) is expanding by bringing together small, specialized companies that operate closely in provinces. And finally, 'technology upstarts' (such as Dangdang.com, Innova Superconductor and Datang Microelectronics) are using innovations developed by China's government owned research institutes to enter emerging sectors of new technology (see Dangdang case example).

Case example: Supply chain of Haier Group in the USA

Haier Group in China is a leading manufacturer of consumer durables with an annual turnover of about $9 billion. By the early 1990s the company had battled Whirlpool, Electrolux, Siemens and Matsushita to become the leader in China's market for home appliances. The group is now leaders with 250 types of refrigerators, air conditioners, dish washers and ovens, and in the USA alone its market share is about 50 per cent.

When it entered the US market in 1994 it focused on selling only compact refrigerators (smaller than 180 litres) for hotel rooms and student bed sitters. In 1997 Haier entered the market for wine coolers and captured the 60 per cent of that specialized segment by 2002. The company set up a manufacturing facility in Camden, South Carolina, to bypass the non-tariff barriers imposed by the USA on imports of appliances. Haier formed partnership with nine of the ten largest retail chain in the USA to carry and sell its products.

Haier customers did not demand ground breaking innovation or state-of-the-art technologies; they only wanted reliable and value for money products to meet their needs. The success of Haier in the US market demonstrated that Chinese companies are not only the suppliers of outsourced manufacturing facilities with cheap labour, but also they are now global competitors in advanced economies.

Source: Zeng and Williamson (2007)

Case example: e-Supply chain in China: dangdang.com

By 2003, Dangdang.com (dangdang) was rated as one of the most successful online bookstores in China. It featured almost 90 per cent of the books published in China. Dangdong launched in November 1999 by Peggy Yu, an MBA graduate from New York, and Li Guoging, a Chinese entrepreneur, recorded sales worth China Yuan Renminbi (CNY) 1 million in the first 2 months. In a year's time, Dangdang was ranked as the number one online bookstore in China.

After studying the model of Amazon.com, Li Guoqing and PeggyYu, realized that the website owed its success largely to its vast database of titles. It took the couple almost 2 years to make a comprehensive database of 200,000 book titles published in China. Ironically in 2004 they turned down an offer from Amazon, who then invested in their major Chinese rival Joyo.

In November 1999, they launched the Dangdang website. Dangdang was chosen as a name because it could be easily pronounced, remembered, and typed. Dangdang is derived from the Chinese adjective xiangdang-dang, meaning resounding and worthy.

Within 1 year of its launch in 2000, Dangdang was ranked first among China's five major online bookstores by a significant margin in a survey conducted by the local industry publication, Computer Business Information. The most popular books on Dangdang.com are on computers, English language learning, science and tourism.

In April 2000, Softbank China Venture Capital (SCVC) and IDG invested $22 million in Dangdang. This was to be used to strengthen Dangdang's logistics. Dangdang planned to build a 10,000 square metres storage facility in Beijing and expand its delivery system to 40 major cities in China. It also had plans of getting listed on the US Nasdaq stock market, by the end of 2000. But following the crash in tech stocks, it postponed its plans indefinitely. Subsequently, in 2006, Dangdang was able to attract substantial venture finance from the USA to fund the development needed.

Prior to the launch of Dangdang, online bookstores such as bookmall.com, cp1897.com, 8848.net were already operational. The success of Dangdang inspired the opening of a few more online bookstores. While Dangdang was considered the most competitive in terms of price and variety of products; Joyo.com (joyo) offered more popular products; bol.com (bolchina) had the biggest advertising budget and store. sohu.com (store.sohu) had a good brand name and heavy traffic.

In October 2002, Joyo, Bolchina, Dangdang and Store.sohu were engaged in a price war. All these websites sold books and audio–video products online. The list price of the Chinese version of *The Lord of the Rings* trilogy was CNY 62.6 per set whereas the websites were selling it at 40 per cent below list price for CNY 45. Similarly, another bestseller, *Harry Potter* was also sold on websites at heavy discounts. These players were mainly aiming for market share and were willing to sacrifice profits to acquire this.

Source: www.chinatechnews.com (April 2007)

The potential of setting up joint ventures and expanding businesses for multinationals is tremendous. However, the risk of operating a supply chain needs to be analyzed in a hard-nosed way. These risks could include the politics of the World Trade Organization, implementation, oversupply and possible deflation, the structure of political power and political stability, and currency exchange fluctuations. Lieberthal and Lieberthal (2003) recommend a five-stage strategy for Western multinationals to consider business expansions in China:

- Focus attention on properly nesting your China strategy into the organization as a whole.
- Tailor strategies to both national and local governments and markets.
- Adopt a 'show me' attitude toward the purported advantages of forming a joint venture.

- Recognize and take steps to minimize the particular risk of operating in the Chinese environment.
- Avoid irrational exuberance in responding to the opportunities that China presents.

Supply chain in Latin America

Latin American countries have a current total population of over 370 million. The economy for Latin America gained momentum in the recent years of the 21st century, bolstered initially by robust global demand and strong commodity prices. This was followed from 2000, by a brisk pickup in household consumption and business investment. According to the International Monetary Fund (2005) 'It is likely that region-wide growth in 2004 was even higher than the 4.5 per cent forecast of last autumn, and the best since 1997. This result is even more encouraging since it was achieved with moderate inflation'.

There has also been a remarkable turnaround in the region's external position, with a small current account surplus likely to have been achieved. Considering the region's history of macroeconomic and political instability, these are all welcome developments. Individual performances of Mexico, Brazil, Argentina and Chile are examples of these positive trends. The economic development of Latin America is bolstered by regional 'common market' agreements such as Mercosur and NAFTA (North American Free Trade Agreement).

The Mercosur or Mercosul was created by Argentina, Brazil, Paraguay and Uruguay in March 1991 with the signing of the Treaty of Asuncion, subsequently amended in 1994 by the Treaty of Ouro Preto, Mercosur was originally set up with the ambitious goal of creating a common market/customs union between the participating countries on the basis of various forms of economic co-operation that had been taking place between Argentina and Brazil since 1986. Bolivia, Chile, Colombia, Ecuador and Peru currently have associate member status. Venezuela became a full member in 2006. The organization has a South and Central America integration vocation.

In January 1994, Canada, the United States and Mexico launched NAFTA and formed the world's largest free trade area. The Agreement has brought economic growth and rising standards of living for people in all three countries. In addition, NAFTA has established a strong foundation for future growth and has set a valuable example of the benefits of trade liberalization.

Clearly, Latin America still faces significant challenges, perhaps the most pressing of which is how to step up the pace of economic growth while maintaining stability. It is well known that in 2004, a year in which all developing country regions posted strong economic growth rates, growth in Latin America was less vigorous. The main reason for this was the collapse of the Argentine economy in 2001. Throughout Latin America unemployment and poverty remain unacceptably high, and severe income disparities persist. The primitive transport and logistics infrastructures in the remote interiors of especially Brazil, Bolivia and Colombia is encouraging population over spilling into urban slums around mega cities such as Mexico, Sao Paulo, Rio de Janiro, Buenos Aires and Bogota. The current favorable economic environment in North America and generally in the world provides an excellent backdrop against which action can be taken to ease these vulnerabilities.

Many Latin American companies have become world class businesses by capitalizing their link with multinational companies like Proctor and Gamble, Unilever and global car and drugs manufacturers. Multinationals also utilized both people skills and markets of Latin American countries to consolidate their global earnings, systems and business practices. In this regard local companies in China and India have been more successful in blunting the multinationals' edge. However there are limited examples of a local company (such as AmBev and Bunge in Brazil and Cemex in Mexico) which have judiciously adapted to the special characteristics of local customers, suppliers and infrastructure. The following three case examples illustrate some of the developments of supply chain management in Latin America.

Case Example: Data warehouse system in Unilever Latin America

Unilever Latin America, the fast-moving consumer goods conglomerate, was facing the challenge of tracking business performance in a single data warehouse in 34 companies, 19 countries and currencies, thousands of users, three languages and operating over five time zones. The organization had multiple Enterprise Resources Planning (ERP) and Customer Relationship Management (CRM) systems from various vendors, as well as 34 custom-built data warehouses, adding up to about 150 separate information systems and coding structures.

Each country had its own way of classifying information. Supply chain, ERP and CRM systems, for example, had different ways of classifying products and customers from country to country. 'Companies and countries have different cultures, different ways to run the business', notes Monica Parisi, information architecture manager at Unilever Latin America in San Paolo, Brazil.

Faced with a constantly changing marketplace where acquisitions and consolidations abound, Unilever Latin America believed there had to be an easier way to track regional information and improve business performance. So it initiated a Dynamic Information Warehouse system to help harmonize processes and information through a project called Sinfonia, the Portuguese word for symphony.

Sinfonia is replacing all of Unilever Latin America's local ERP systems for finance, supply chain and order-to-cash processes. For this to work, Unilever needed to extract data from a wide variety of systems, including SAP, Siebel, Manugistics, PeopleSoft and legacy applications. In addition, the solution had to be adaptable to rapid and dramatic business changes.

Unilever Latin America has successfully implemented Sinfonia in Argentina, Paraguay, Uruguay, Chile and Brazil. ‘That represents more than 50 per cent of the revenue or sales of the total region’, according to Parisi. The organization is halfway to reaching its goal of implementing Sinfonia across the entire region.

The implementation thus far supports more than 2000 business users. Unilever Latin America expects that the final project will support more than 4000 users with about 12 million records loaded per day.

Sinfonia delivers an aggregated view of data across Unilever Latin America at high speed throughout constant business changes such as acquisitions and market consolidation.

That was the most significant challenge the organization had to conquer: harmonization across companies and countries. The overall architecture presented another challenge because Unilever Latin America had limited experience with very large databases. It brought in a team of consultants from Accenture, NetPartners and Kalido to help put Sinfonia in place.

Unilever Latin America’s vision is to deliver the right information at the right time to the right people. Sinfonia is helping that vision become reality through daily monitoring of the extended supply chain. The organization can dynamically generate information to track and manage the full supply chain from production to delivery.

What used to take the organization a couple of weeks to determine performance information across the entire region can now be done immediately, online, even as Unilever Latin America, its suppliers or its customers are changing.

Unilever Latin America intends to grow Sinfonia and to incorporate supply chain, finance and human resource processes into the mix. Eventually, the data warehouse will feed a regional Balanced Scorecard application as an executive information system and assist in strategic business planning. This will happen by enabling existing data to be viewed according to possible future hierarchies.

If given the opportunity to redo the project, Unilever Latin America would use internal people that could learn and stay with the development team, Parisi notes. The organization began developing the system with third parties and consultants.

Source: Unilever Brazil (2004)

Case example: Bristol-Myers Squibb supplier partnership in Mexico

Bristol-Myers Squibb in Mexico has adopted supplier management as part of its sustainability 2010 goals. In July 2006, the San Angel facility organized an event to recognize those suppliers to Bristol-Myers Squibb and other companies who participated in Phase I of the eco-efficiency program 'Competitive Chains'. Phase I was held from October 2005 to April 2006 and resulted in the identification of more than $1 million in cost savings. Written recognition was presented to the suppliers by the Ministry of Environment. Phase II of the program was launched in July 2006, with the participation of suppliers to Bristol-Myers Squibb and other companies.

The company has developed an environment, health and safety (EHS) questionnaire that may be sent to most third-party manufacturers and to a contractor or supplier if it falls into one of the following categories:

- Sole source
- Manufacturer of a strategic material
- Manufacturer of a material to Bristol-Myers Squibb's specifications
- Referenced in a New Drug Application submitted to the US Food and Drug Administration

Based on the results of the questionnaire, a site evaluation is conducted. The evaluation team will make recommendations and then develop and track an action plan for the contractor.

Source: Bristol-Myers Squibb website (www.bms.com) (2006)

Case example: Oilseeds supply chain in Brazil

Founded in 1818 in Amsterdam, Bunge is a leading agribusiness and food company with integrated operations that circle the globe, stretching from the farm field to the retail shelf. Bunge in Brazil is the largest producer of oilseeds in the world. The company has created a supply chain that links Brazil's farmers to customers all over the world.

The trading departments of the company track the supply and demand of oil seeds and decide when to buy oil seeds, when and where to crush them and when and where to transport oil products to customers. Bunge charters about 100 ships and leases warehouses and oil mills all over the world. The flexible infrastructure allows the company to respond quickly to changes in customer requirements and also to cope with logistics problems. The company feeds supply and demand data to Brazil's farmers along with technical advise so that the farmers can plant the right kind of oilseeds. Bunge's sales grew by 235 per cent between 1997 and 2004, from $7.4 billion to $25 billion.

Source: Khanna and Palepu (2006)

Summary

In this chapter we have discussed the shift of product and services supply in the global market due to emergence of stronger so called, second and third world economies. The supply strategy of established multinationals of the West and Japan and Korea has been remodelled by enhanced outsourcing to the emerging markets and at the same time big organizations particularly from China and India have extended their supply base as a global player. The organizations in Latin America and the Eastern Europe are less dominant in the global market but their local economies and infrastructure are benefiting from the expansion activities of multinationals.

Both the local organizations and multinationals are capitalizing and adapting to the specific opportunities and challenges of the emerging markets. These include the availability of both low cost semi skilled and highly skilled labour, expanding consumer demands especially in China and India, developing transport and logistics infrastructure, the importance of execution and governance according to local regulations and finally the market structures in developing countries. Khanna and Palepu (2006) suggest that the 'four tiered' structure (see Figure 11.2) of markets in emerging economies helps local companies counter their multinational rivals.

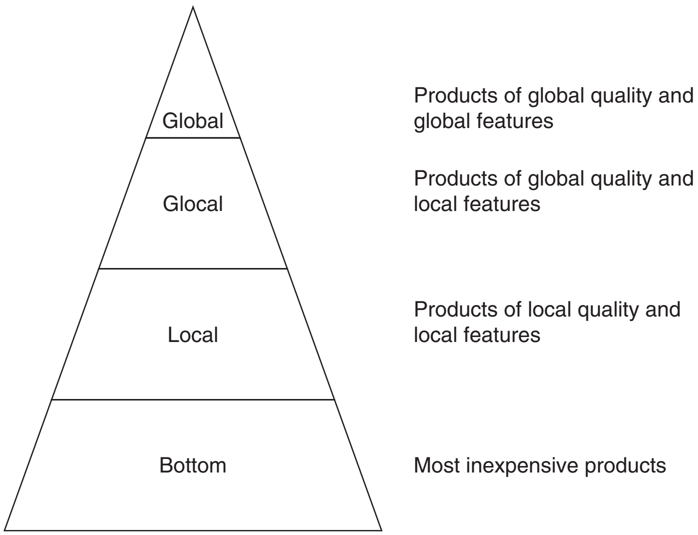

Figure 11.2 The four-tiered structure of emerging markets.

At the apex of this pyramid structure is the 'global' tier where global customers want products of global quality with global features and are willing to pay global prices for them. The second tier is the 'glocal' segment where products are of global quality but with local features and prices are cheaper than offered by developed countries. The customers in the third or 'local' tier are happy with products of local quality and at local prices. The 'bottom' tier of the market consists of consumers who can only afford to buy the most inexpensive products. The markets for talents and capitals in developing countries are also roughly structured along the same 'four tier' hierarchy. Multinationals typically compete in the 'global' tier while smart local companies dominate the 'local' and 'bottom' tiers move into the 'glocal' tier. However some multinational corporations with a robust local representation (e.g. Hindustan Lever in India) are also attempting to compete in lower tiers.

12

e-Supply chain

Introduction

There is no doubt that supply chain order fulfilment is the Achilles heel of the e-business economy. At the beginning of every e-commerce, on-line trading and virtual supply chain there is a factory, a warehouse and a transport. Internet has elevated the performance of information accessibility, currency transactions and data accuracy, but the real effectiveness of supply chain from the source to customer cannot be achieved without the efficient physical movement of goods and materials through the supply chain. Web-based software and e-market places have increased the alternatives available to e-supply chain managers in all types of operations including service industries. More opportunities mean more options and complexity. Therefore, it is vital that a process is in place to monitor the performance of e-supply chain for both virtual and physical activities. A Balanced Scorecard approach of performance management will ensure the sustainability of an e-business when it becomes a stable operation after the project stage.

In order to facilitate communications between software used by internal supply chain partners, multinational companies have tried very hard, but generally unsuccessfully, to standardize computer systems. The emergence of the Internet protocol has helped the interaction between powerful supply chain systems such as i2, Manugistics, Ariba, Oracle and SAP R/3 to name a few. The rigour and problems related to the validation process still remain. In spite of the complexity and regulatory requirements, or perhaps because of it, the healthcare industry remains a huge untapped market for e-supply chain. A recent study carried out in the USA by Efficient Healthcare Consumer Response (EHCR) consortium showed that the healthcare industry could reduce its overall supply chain costs by over US $11 billion (48 per cent of the current process cost) through the efficient application of collaborative e-supply chains.

Peter Drucker once said, ‘Alliances are where the real growth is’. In the market driven competitive world, businesses are continuously seeking new strategies and business models to excel. They strive to update the process and metrics used to measure and improve performance. The Internet is providing companies both with new challenges and potential solutions. Arguably, the biggest external factor that is revolutionizing business culture is the power of the Internet. One such area of impact is collaborative supply chain.

The idea of a collaborative economy is not entirely new. Over the past decades strategic collaborations and global sourcing have become a familiar business strategy. Even during the 1970s and 1980s multinational companies were setting up manufacturing sites to meet local demand and regulatory requirements. In terms of industrial relations it was considered a high-risk strategy to focus sourcing from a small number of sites. However, with gradual de-regulation and the improved manufacturing capabilities of the developing markets, the strategy of global sourcing and third-party supply began to advance forward. Perhaps the biggest transformation in collaborative economy has been enabled by the Internet and information systems. The visibility of real-time information, round the clock on-line trading and the gradual shift in power from suppliers to customers have accelerated this transformation.

As indicated in Chapter 1, the Internet-enabled integrated supply chain or e-supply chain has extended the linear flow of the supply chain to an Eco system (see glossary) or a supply web (see Figure 1.4). It now includes all suppliers and customers to the end user or consumers suppliers' customers and customers' suppliers and so on. e-Supply chains and more broadly e-businesses have enhanced supply chain efficiency and effectiveness by sharing real-time information regarding forecasts, inventory, order status and other key information between partners. The process of e-supply chain is going through a rapid change through both technology and application. We will cover some of these opportunities and challenges under the following headings:

- e-Supply chain enabling technology
- e-Supply chain processes
- e-Supply chain strategy
- e-Supply chain applications (case examples)
- e-Supply chain learning points

e-Supply chain enabling technology

Adapting from Kulkarni (2005) we define three key components in the implementation of an e-supply chain:

1. Implementation of an ERP or enterprise resource planning (such as SAP R/3 and PeopleSoft) software in an organization.
2. Adoption of collaborative planning and scheduling with critical suppliers and customers allowing effective sharing of forecasts and order status. This is also known as CPFR (Collaborative Planning Forecasting and Replenishment) and is supported by so called Global Supply Chain (GSC) software (such as i2 and Manugistics).
3. Electronic linking of customer and supplier data using Internet technologies. This allows virtual communication between customers and suppliers anytime anywhere.

The complex web and infrastructure of e-supply chain will be discussed in more details in Chapter 17. Such complex elements are usually in the domain of ICT (information and communication technology) specialist. In this section we cover some basic technology enablers which are accessible to traditional users and stakeholders of supply chain management (SCM). These are EDI (electronic data exchange), Intranets, Extranets and Business to business (B2B) Portals.

Electronic data exchange

EDI is computer to computer direct transfer of business data through electronic media between organizations and partners. It helps real-time information exchange between locations far apart and enables significant reduction in lead time and improves the accuracy of shared data. Despite being relatively unheralded, in this era of technologies such as XMLservices, the Internet and the World Wide Web, EDI is still the data format used by the vast majority of electronic commerce transactions in the world.

Intranets

Intranet is an Internet linked network inside an organization secured behind its ‘firewalls’. The Intranets helps to share documents between employees only, with given password controlled access, regardless of their geographic locations. Most companies have Intranet-based websites for internal use.

Extranets

According to Smith (2001), Extranets combine the privacy and security of Intranets with the global reach of the Internet, allowing access to external partners, suppliers and customers to a controlled portion of the enterprise network, such the ERP system.

Case example: Extranet

Adaptec Inc. is a $1 billion microchip manufacturer supplying critical components to electronic equipment makers. The company, with its headquarters based in California, outsources the manufacturing tasks and concentrates on product research and development.

Before the introduction of Extranet Adaptec required 15 weeks to deliver products to customers. Some competitors were known to deliver similar chips within 8 weeks. The longer delivery time was mainly caused by the need to co-ordinate design activities between the head office in California and the three manufacturing sites in Japan, Hon Kong and Taiwan. After the introduction of Extarnet links beween partners supported by enterprise level supply chain integration software the communication with manufacturers in different zones became easy. Adaptec can send chip design diagrams and changes over the Extranet, enabling the manufacturer to prepare for product changes and new design, and lead time reduced below 4 weeks.

Source: PSG Institute of Management,

B2B portals

With the advent of Internet it is easy for buyers and suppliers to meet, buy and sell across cyber market places and collaborate more quickly than the traditional way. These are also known as B2B and are classified under Net market places and Private market places. Net market places are independently owned portals that bring numerous suppliers and buyers to cyberspace in a real-time environment. They could be either industry orientated vertical market places (e.g. metalsite.com) or product or service orientated horizontal market places (e.g. tradeout.com). A Private market place is a trading hub in which membership is closed or by invitation or subscription only.

e-Supply chain processes

e-Supply chain processes conform broadly to the building blocks of a traditional supply chain plus a fundamental component which is visibility. Visibility of information across the supply chain allows supply chain partners to automate some of their internal processes. For example, if a manufacturer knows the inventory level of the retailer then the replenishment process can be automated by VMI (vendor managed inventory) policy. This type of workflow automation within the supply chain forms the second characteristics of e-supply chain processes. Finally, a formal process of collaborative planning is required to harness greater efficiency and effectiveness from visibility and workflow automation. Figure 12.1 shows a framework of e-supply chain processes to complement the traditional supply chain building blocks.

The communication technologies such as Internet and wireless, information technologies such as XML, Java, etc. and information systems such as ERP have made the flow and accessibility of information seamless, visible and in real time. It is now possible to instantly trace an order placed with a retailer to the database of the OEM (original equipment manufacturer) and the intermediate suppliers can plan their activities to meet the requirement of the specific order.

The second characteristic of workflow automation uses automation tools to integrate the commonly occurring interactions between the stakeholders and companies of a supply chain. Some of the commonly deployed workflow automation applications include available to promise, VMI, electronic procurement and dynamic pricing. By harnessing the visibility within the supply chain and the automation applications current ERP systems (such as SAP R/3)

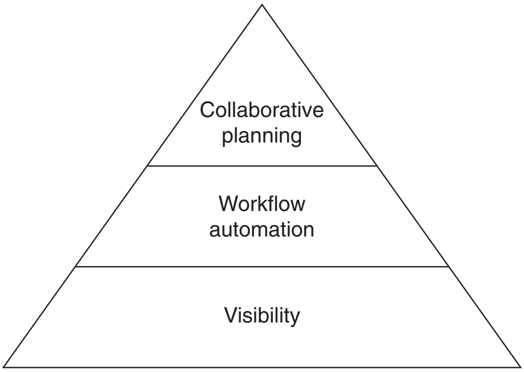

Figure 12.1 A framework of e-supply chain processes.

and SCM systems (such as Manugistics) are enabling workflow automation requirements.

In spite of the great opportunities provided by supply chain visibility and workflow automation the true potential of e-supply chain can only be realized when it is supported by an executive decision-making process that optimizes the automated flow of materials based on the information available from supply chain visibility. This executive decision process is collaborative planning which can only be effective through a real-time communication network via Intranet, Extranet and B2B portals (or trading hubs) and a sales and operations planning (S&OP) process. Figure 12.2 show the e-supply chain communication network of a pharmaceutical company. The S&OP is described in Chapter 16.

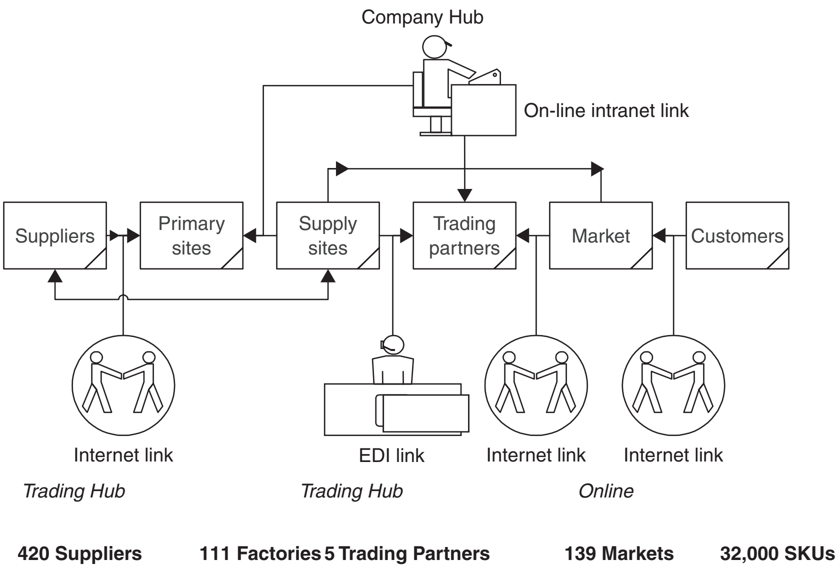

Figure 12.2 e-Supply chain in a pharmaceutical company.

It is important the key suppliers and partners are included in the S&OP meetings of the OEM.

e-Supply chain strategy

e-Supply chains are rapidly making inroad in all types of organizations and sooner or later most major players of SCM will voluntarily or involuntarily adopt e-supply chain management. It is still treated as a competitive advantage when all systems and infrastructure work well and not as a commodity like telephone. The fact is if you do not rapidly adapt to e-supply chain you are likely to be left behind with the traditional ways of information exchange and your service will not be cost effective and will be outmoded by new standards of performance. The following Table 12.1 shows the impact of Internet in the cost per transaction in a bank.

Table 12.1 Transaction costs in banking

Channel	Cost per transaction (US $)
Branch	1.07
Telephone	0.54
Automated teller machine	0.27
Internet	0.01

Source: Booz Allen Hamilton (July 2006)

There is also the influence of big multinational companies who have implemented e-business network with their suppliers and partners. According to Donavan (2004), one CEO of a large US conglomerate is quoted as saying, '… all of our suppliers will supply us on Internet or they won't do business with us'. There is little doubt that heavy emphasis and investment of resources have deployed by larger organizations to implement sophisticated e-supply chain. Suppliers, regardless of size, should have got the clear message that the e-supply chain has arrived and is here to stay.

However it is important to note that just throwing more software at the problem is not the answer to the core issues of SCM. Although software and web-based network are need it is also very necessary to define the process information flow at the right time and ensure accurate data into the systems. Good supply chain practioners know that information should be passed on only to those who need to know and use it in the form they need to have it. The ambition and expectation of many so-called 'dot.com' companies ended in failure in late 1990s mainly because of not spending enough time on up-front strategy development. Basu and Wright (2004) expressed a cautionary note for all types of change management. 'Major, panic driven changes can destroy a company. A poorly planned change is worse than no change'.

In view of the above opportunities and challenges of Internet driven ICT revolution we recommend that the following considerations should be included during the development of an e-supply chain strategy in any organization:

1. It is evident that e-supply chain strategy will be mostly driven and financed by large multi-site and multi-national companies. Only partial benefits will be achieved if the e-supply chain initiatives of larger companies focus solely for their own operations and sites and do not include the key suppliers. Proactive policy should be in place in larger organizations to involve and train key partners in the development and implementation of an e-supply chain network.
2. Smaller organizations and suppliers should incorporate in their business strategy how to keep abreast with ICT technologies affecting their supply chains. It is important to co-operate fully with OEMs and larger customers in their e-supply chain programmes. Often relatively smaller companies may develop specialization and expertise in specific operations or outsourced services (e.g. IT support) and they contribute a key link to the e-supply chain strategy.
3. Spending more time at the front end of e-strategy development for improving order to delivery cycle and SCM will pay good dividends. The challenging aspect is to think through an e-supply chain strategy, network and appropriate infrastructure that will improve your performance ahead of your competitors. It is essential to design an appropriate roadmap and do it right first time.
4. The e-supply chain network and infrastructure should emphasize workflow automation and at the same time should accommodate some degree of flexibility to interface with non-automated suppliers. This consideration of system flexibility could be of particular importance for conducting business with emerging markets such as China and India.
5. It is paramount that before embarking on an e-supply chain programme companies understand their supply chain priorities and the structure of Internet-enabled linkages with key suppliers and partners. The real benefits of an e-supply chain and the cost of implementing and maintaining it must be properly evaluated before taking a big leap into the e-supply chain.
6. It must be emphasized that the success of the systems in an e-supply chain will depend on the robustness and lean or agile characteristics of basic processes and the velocity of flow. Therefore, the re-engineering of the key business processes in the supply chain before the implementation of systems should be an essential part of an e-supply chain strategy.
7. Having understood the fundamentals of e-supply chains it is also necessary to understand the emerging trends in supply chains that will impact the nature of future e-supply chains and consequently the e-supply chain strategy. Such trends include customer centric supply chain (see Figure 12.3) and outsourcing of supply chain activities. The customer centric supply chain is basically a 'pull system' and is also branded as Demand Driven Supply Chain. Companies such a FedEx, UPS, DHL and InSite offer professional logistics and supply chain services customized to the user requirements. The trend of outsourcing logistics to third-party service providers (known as 3PLs) is fast

gathering momentum. Outsourcing a major logistics contract is a strategic business decision and should also be part of e-supply chain strategy.

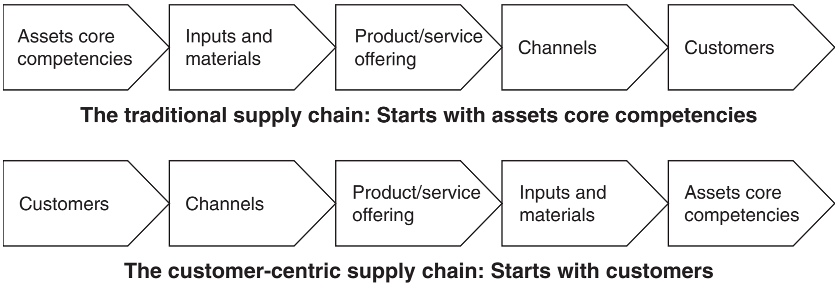

Figure 12.3 Customer centricity.

e-Supply chain applications

Organizations today are faced with an incredible number of choices of web-based procurement applications, forward and reverse on-line auctions, vertical and horizontal marketplaces, global supply networking, collaborative planning and forecasting applications, electronic catalogues and so on. These and other applications comprise the e-supply chain applications that are in various stages of development today. Many companies are focused on buy-side order management applications (i.e. Ariba, Frictionless, CommerceOne, etc.) as the end-all solution to conducting business in the Internet economy. These buy-side procurement applications can help companies reduce costs by directing more spend to strategic suppliers enforcing standard product selections, and reducing transaction costs and cycle times. However, the e-supply chain universe is much more than buy-side procurement applications. It is generally perceived that the e-business revolution is taking place mainly in the new environment created by young ‘dot.com’ entrepreneurs. This is of course a partial view of e-commerce. The real changes are also happening quietly within ‘traditional’ or ‘old economy’ companies. This is fast changing area but one in which corporate stories of success and failure are beginning to emerge.

We have, therefore, chosen one case example of a small enterprise promoting e-procurement and three case examples to illustrate the application of e-supply chain in established businesses and there solutions are not strictly in the buy-side procurement applications.

Case example: e-LabSHOP from Biotech Analytics UK

Biotech Analytics offers a biotech-dedicated portal that provides on-line resources for the biotechnology sector. Founded in 1997, Biotech Analytics is a member of the Bio-Industry Association, UK. Its services include the provision of FSA regulated independent financial research and analysis of all UK biotechnology companies for investors.

Using Izodia InTrade business-to-business trading community software, Biotech Analytics has developed a customized on-line marketplace called e-labSHOP. It is designed to offer purchasers and suppliers of laboratory products a single resource that simplifies and streamlines the product search and ordering process. e-LabSHOP integrates with suppliers existing sales processes and purchasers can thus browse, order or transact via a single order point that is customized to their organization's authorization protocols.

Currently Biotech Analytics is operating an e-labSHOP pilot. The participants include Teklab (ML) Limited, Scientific Systems Design Inc., Campsec Limited and a large government scientific research institution. Once live, e-labSHOP will make available on-line a broad range of biotech consumable products and services and by using e-labSHOP biotechnology companies, research institutes and universities will be able to buy goods and services on-line.

The potential financial benefits for the users include:

(a) *For scientists*
- Elimination of purchasing paper chain
- Electronic authorization process
- Saving time by viewing catalogue information from multiple suppliers
- Reduction in errors

(b) *For purchasing organizations*
- Improved efficiency in the purchasing process
- On-line internal accounts maintenance
- Multiple site organizations can collate purchasing power by aggregate orders

(c) *For suppliers*
- Receive aggregated orders and minimize administration costs for small orders
- Expand geographically without increasing sales force
- Reduction in incoming erroneous orders

(d) *For Biotech Analytics*
- Licence fee from subscribers
- Increase customer base
- Market products to a highly specific scientific audience

A Business Case for Wolfson Institute

The application e-labSHOP in Wolfson Institute is a good example of an e-procurement solution for scientists. With reasonable assumptions and from the current data it may be possible to justify a business case based on the improvement in productivity. Wolfson Institute for Biomedical Research was founded in 1995 as part of University College London. It is funded by many sources Wellcome Trust, MRC and industries. By 2002, the staff level reached about 250 and it has teaching facilities for 1200 medical students.

Current data

Income	£10 million per annum
External orders	360 per annum
Number of lines	1090
Average value of order	£350
Error rate	13.5%
Transaction fee (e-lab)	5% of order value

Assumptions

Loaded scientist cost	£50,000 per annum
	= £25 per hour
Time to prepare and authorize an order	= 75 minutes
Time to order electronically	= 15 minutes
Document cost per order	= £5
Error rate in e-procurement	= 3.5%

Calculations

Average cost of a manual order	$= 25 \times 75/60 + 5 =$ £36.25
Average cost of an electronic order	$= 25 \times 15/60 =$ £6.25
Average saving per order	= £30
Saving in ordering cost per year	$= 30 \times 360 =$ £10,800 per annum
Saving due to 10% reduction in error	$= 0.1 \times 360 \times 36.25 =$ £1305 per annum
Transaction charges at 5%	$= 0.05 \times 350 \times 360 =$ £6300 per annum
Net savings per year	= £5805 per annum

Naturally, the costs and savings of an e-procurement initiative will vary according to the size and complexity of operations and the assumptions made to calculate them. In a large pharmaceutical organization the company may wish to develop their own e-procurement solution. The investment could include the software cost (£50,000+) and the implementation cost associated with the customization of the software. In such an initiative a traditional return on investment (ROI) approach is appropriate. However, for smaller organizations such as WIBR it appears sensible to use systems such as e-labSHOP where functionalities have been tried, validated and implemented. Each organization will avoid the investment cost and see their purchasing solution customized for them.

Source: Basu (2002)

Case example: Sainsbury's e-supply chain

The company

Sainsbury's opened its first grocery store in 1869 in London's West End. The business has grown to encompass over 400 'supermarket' stores generating a turnover of over £12 billion. In a low margin, fiercely competitive consumer market, Sainsbury's is still aiming for growth with a strategy of bringing the best products and excellent service to an increasing number of consumers. However, the company's market leadership has been threatened by the dominance of Tesco and the muscle of Wallmart following their acquisition of Asda.

Drivers for e-supply chain

The quality and perception of customer service is the key driver for the success or failure of a retail business. The visible aspects of customer service are demonstrated by the quality or freshness of produce sold, the choice available (for instance, vegetarian or organic choices) and, to a certain extent, the cost of items. The visible customer can only be as good as the invisible supply chain that supports it. The effectiveness of this supply chain is determined by the speed of response and availability of products. A further consideration is the cost of supporting the supply chain including the stock holding rate.

During the 1990s, Sainsbury's adapted three detailed initiatives to improve the effectiveness of the supply chain:

1. Centralization of the supply chain
2. Centralization of logistics management
3. Value chain initiative (VCI)

Sainsbury's wanted to apply a 'just-in-time' (JIT) supply chain enabling a continuous flow of products as and when the stores needed them. Under the old process, products were passed from group to group requiring several stops and this reduced responsiveness. There was a lack of ownership for the causes of delays, creating further difficulties. Following the centralization of the supply chain under Logistics Management, half of the group focused on business processes and the other half was devoted to the development of IT systems.

The second initiative to satisfy the consumer is based on what is known as efficient consumer response (ECR). This aims to provide the retail consumer with the best quality service through collaborative supply chain operations. It relies on both the retailer's (viz. Sainsbury's) and the supplier's (e.g. Unilever) supply chain. Thus, the sharing of information between the systems of different partners within that chain is essential. ECR has been a philosophy put into practice within the retail market in Europe since the mid-1990s and Sainsbury's has embraced it. ECR encourages retailers and suppliers to share common data on promotion, demand planning and inventory levels. When this information sharing is feasible, significant savings can be made by optimizing the order size and stock levels while at the same time improving the availability of products.

The VCI is an extension of the type of information sharing practised in ECR. It aims to improve end-to-end supply chain efficiencies from the sourcing of raw materials to the delivery of finished products in the consumer's hands. The goal of VCI is to link systems applications in a number of supply chain industries (e.g. distribution, import/export, warehousing) and share dynamic business information between new and existing trading partners. Sainsbury's is a proactive partner of VCI.

The above initiatives could not be effectively supported by traditional communication methods. 'We needed to look at further IT solutions that would enable the communication process to be effective', says John Rowe, Director of Logistics at Sainsbury's.

The e-supply chain solution

After evaluating several off-the-shelf applications, the IT Team at Sainsbury's concluded that a B2B e-commerce system would have the potential to meet their requirements. They chose a solution called the 'EQOS Collaborator'.

The EQOS Collaborator was developed using Microsoft technology tools that allowed companies to publish information that could be viewed easily and downloaded into 'legacy' systems and back. The majority of companies including Sainsbury's standardized on Microsoft technology. The wide range of MS tools and available skills in the market was also an important factor.

The system was built on a Microsoft Windows NT server platform, by a Microsoft Internet Information Server and browsed by a Microsoft Internet Explorer. The database is a Microsoft SQL server but the information can be integrated into other legacy databases. The main program for displaying further applications is EQOS Administrator which has been developed by using Microsoft Visual Basic and e-commerce functionality.

The EQOS Collaborator solution allows companies in the total value chain to automate and share-business information on a real-time basis amongst customers, suppliers, distributors and retailers.

Business benefits

The Internet-based information sharing and collaborations system (EQOS Collaborator) went live for Sainsbury's in 1998 and so far has demonstrated some significant business benefits.

A tangible advantage was achieved in the area of the forecasting of promotional uplift. The real-time information in the system exposed the fact that in some cases, suppliers had different expectations, but the data was visible before the start of promotion and allowed Sainsbury's to go back to suppliers to agree revised dates and estimates.

The project enhanced the partnership with key suppliers. For example, Nestlé agreed to participate in the web-based collaboration system and heavily invested to ensure interfaces with their legacy systems. The EQOS collaborator enabled the realization of an opportunity to synchronize dynamic supply chain information between suppliers and customers.

Another hidden plus point is the ability to pass on consumer comments to suppliers in an efficient manner. Previously, paperwork was complex and feedback was slow. Significantly, the EQOS system is now available to Sainsbury's suppliers for free.

'Sainsbury's has taken an important lead in shaping the way in and its suppliers can jointly benefit from developing collaborative information systems', comments Mike Quinn, Director of EQOS Systems Ltd.

EQOS is looking to build the Microsoft Commercial Internet Pipeline (CIP) technology into the solution. The CIP would enable a standard method of sharing any type of business critical data using the Internet, e-mail or third-party Virtual Added Networks (VANs). This solution would allow all 4000 of Sainsbury's suppliers to strive towards the ECR principles of integrated supply and demand.

Source: Microsoft (2001)

Case example: GlaxoWellcome e-supply chain

Long before the merger with SmithKline Beecham, GlaxoWellcome embarked upon their Global Supply Chain project in 1996 and the use of e-business within the supply chain was in its infancy then. Following the integration between Glaxo and Wellcome it was evident that the dominance of cash cows such as Zantac and Zovirax would soon be over. In the new level playing field environment the supply chain network of GlaxoWellcome would have to deliver cost, speed, order fulfilment and reliability advantages to the company, and its stakeholders including suppliers, trading partners, wholesalers and internal customers.

The worldwide manufacturing and supply division of the company set up a number of mutually complementary initiatives. Two such projects were most significant for the supply chain performance:

1. GSC supported by Manugistics software
2. International MRPII Programme (IMP) supported by BPCS software

The prime objective of the GSC was to enable forecasting, stock replenishment and visibility of real-time data amongst supply, sites trading partners and market sites. IMP focused on ensuring S&OP and order fulfilment of individual sites.

The Global Supply Chain network of GlaxoWellcome comprised:

- Five primary sites (four in the UK and one in Singapore) for the manufacture of active ingredients.
- Ten FDA approved secondary manufacturing sites in the USA and Europe.
- Two trading partners (Adecsa and Lapsa).
- Forty-one local supply and marketing sites.

At the early stage of the project the trading partners are linked by EDI with the supply sites and most of GW sites were connected by e-mail. The global demand was aggregated and processed at the centre and simulations by Manugistics projected the stock status and replenishment requirements for all supply sites. With the progress of the programme BPCS was replaced by SAP R/3 for FDA approved sites and the ERP databases of local sites wire interfaced with the Manugistics database. The Global S&OP process enabled regular review of demand, supply and inventory, and a stable process was established. The importance of internal market sites reaffirmed the B2B environment of the GW supply chain network. The company embarked upon web-enabled data exchange with key suppliers and smaller markets where the implementation of Manugistics and SAP R/3 were still a long way from reality. The process of e-supply chain started to work in GW and the company started the measurement of key performance measures.

The initiative that underpinned the e-supply chain project was the development of a Balanced Scorecard on a data warehouse management system. The GW sites could access the data warehouse with appropriate password control and compare the site performance with other sites for range of metrics related to customers, suppliers, quality, factory, cost, growth and innovation.

Source: Basu (2002)

Case example: e-Supply chain at Hermes Abrasives

Background

Hermes Schleifmittel (HS) GmbH is a leading manufacturer of abrasives, founded in 1927 with headquarters in Hamburg. Products include coated abrasives as well as bonded abrasives such as vitrified and resin-bonded products using aluminium oxide. Customers are from metal working industry, automotive industry and glass manufacturing industry. Hermes Abrasives tools are also used to produce aesthetically attractive surfaces and precision functional parts in ski industries. Registered and protected trademarks are Hermes, Hermesit, Sapphire Blue and webrax.

Problem

The market for HS is not of growth. The company was facing fresh logistical challenges with regard to order processing system. The new opportunities in globalization and e-businesses made it necessary for the company to re-engineer traditional supply chain strategy and structures. Within the framework of the gobal production network a series of subsidiary units came within the scope of the new structure. There were already numerous internal customer–supplier relationships between individual sites without taking into account the external suppliers and customers. The complexity of an order event is characterized by the multi-level nature of the value chain as shown in Table 12.2.

Table 12.2 The complexity of an order event

Level of order processing	Order handling
Local order	The directly assigned site is the production site
Single-level composite order	The next assigned site is the production site
Two-level composite order	The next but one assigned site is the production site

Solution

HS defined the concept of the 'fractal company' as the creation of company units on the basis of the holistic and seamless view of the organization. The core point of the change was to link sales and distribution to the production factories directly, without a production planning unit. The formal production planning unit became a strategic production planning responsible primarily for the definition of production sites and intercompany scheduling. The change was enabled by an ERP (SAP R/3) to form a holistic solution of e-supply chain as shown in Figure 12.4.

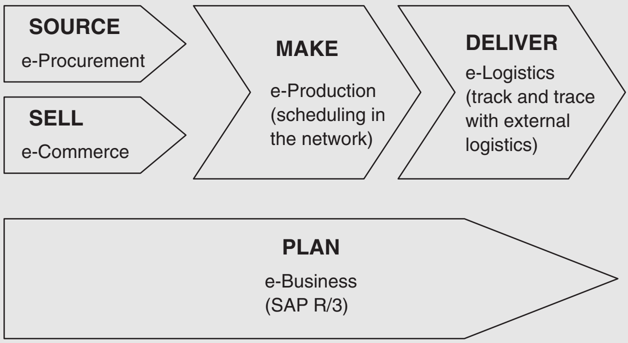

Figure 12.4 e-Supply chain of Hermes Abrasives.
Source: Gasos and Thorben (2003).

The e-supply chain of the company comprised broadly five inter-linked processes, such as source process, sell process, make process, deliver process and plan process.

Source process: Sourcing and acquisition were decentralized, that is production units were responsible for all e-procurement activities.

Sell process: e-Commerce application was directly linked to company's business information system and automatically performed by SAP R/3, the ERP system.

Make process: Orders were navigated automatically through all production sites following an order allocation criteria shown in Table 12.2. On-line displays of order status were also available for tracking orders.

Deliver process: Customers and distributors had facilities to track orders via Internet.

Plan process: The above four processes were underpinned by plan process driven by SAP R/3. All network servers including SAP servers were operated initially under Windows NT which were then updated to Windows XP. A total of 500 users worked on the e-supply chain network in European companies.

Results

The e-supply chain solution offered the company many intangible benefits including the redesigning the business processes, better collaboration and trust between stakeholders and satisfied customers. A sample exercise two years after the start of the project also demonstrated some quantifiable benefits including:

– Increase productivity + 4%
– Delivery service within 24 hours up to 98%
– Reduction in lead time − 40%
– Reduction in despatch complaints − 60%

Source: Gasos and Thorben (2003)

e-Supply chain learning points

The initial optimism that first e-movers would rapidly establish 'new economy' brands has proved unfounded. Nonetheless the recent and chequered history of e-businesses has provided sufficient learning experience and data to develop a strategy for e-business.

Strategy for e-business

- *Continuous review*: Reviewing the impact of e-business in transforming business landscapes, we conclude that we need to keep a close track on its

progress and use that old rule of 'measurement is the driver'. Technology is changing rapidly and we do not have any one-stop solution providers. It is equally important to manage technology, processes, and people culture. This must be borne in mind when developing models for measuring e-business initiatives and processes.
- *Weaker links*: Relative late-comers to e-business have not 'missed the bus', but they must take advantage of this powerful enabling technology. Smaller companies may not be enthusiastic to join the e-supply chain of larger organizations perceiving that the benefits of automation may accrue to larger business partners and not to smaller companies. Appropriate tools for measurement are needed to optimize this open opportunity and bigger players should be proactive in sharing the cost of implementation.

Growth in e-business

e-Commerce will be a growth area, with Gartner (2002) predicting that while its pace will accelerate rapidly, it may be five to ten years before expectations are realized. While the initial hype that B2C e-business will replace traditional sales has been dispelled, it is true that e-business will enhance rather than replace existing revenue generating activities. In the USA, this has been achieved by product focused websites.

- *Electronic global network*: Internet enabling technology has made it possible to link up with both suppliers and customers who did not already share ERP and SCM systems. The e-supply chain will become an acceptable process in both manufacturing and service industries, and ICT managers will be able to take advantage of the collaborative supply chain.
- *Knowledge sharing*: Traditional knowledge management will continue to support both Internet- and Intranet-based e-learning, and indeed all industries are investing in e-KM initiatives. With the inclusion of e-HR, Enterprise Directory and the Intranet, this combined B2E channel will form the largest segment of e-business in which e-supply chain will also be inclusive.
- *Future trend*: The share of wireless Internet users is also set to rise, and interest in the adoption of this new technology is high in most industries. However the technology is challenging and limited, and the telecommunications industry faces an additional problem currently in the difficulty of raising capital. The security of data, which is an area of major concern when a company considers joining an e-supply chain, will continue to be area of detail attention. New security measures like 'encryption' will emerge to protect data so that members of e-supply chain can only have access to data that is relevant to them.

Summary

In this chapter we have described the impact of the Internet driven global information and communication systems in enhancing the management of supply chain processes. The Internet should be viewed as being complementary to traditional ways of competing in business. e-Supply chain as part of e-business is a vital, durable and enduring technology essential for transforming business and business efficiency, a powerful enabling tool that can be harnessed and utilized in almost any business. We have also suggested strategies preferably led by larger organizations how to take advantage of new technology in the expansion of globalized markets and emerging sources. These strategies should be assessed in the light of learning points from the recent and chequered history of e-businesses.

It is to be noted, as we have emphasized in S&OP in Chapter 17, the technology, systems and processes of e-supply chain (such as CPFR) cannot be effective without human involvement and management and the support of a proven review process such as S&OP.

13

Lean and agile supply chain

Introduction

With the real-time access to the Internet and search engines like Google and with the increased global competition, customers have more power than ever before. They demand innovative product features, greater speed, more product variety, dependable performance and quality at a best in class and at a competitive price. Furthermore, today's discerning consumers expect fulfilment of demand almost instantly. The risk attached to traditional forecast driven lengthy supply line has become untenable for consumer products. In this chapter, we discuss how to take up this challenge through a lean and/or agile supply chain. As we discussed in Chapter 3 (see Figure 3.6), a distinction is often drawn between the philosophy of leanness and agility. Like the perennial business phrase 'quality' both 'leanness' and 'agility', there appears to be differing opinions as to what is meant or intended.

In their 'pure' form three models of supply chain can be identified being traditional, lean and agile.

- *Traditional* – Known for:
  - Protection of market, aims for leadership
  - Forecast driven
  - Higher emphasis on customer service than cost
  - Inventory held to buffer fluctuations in demand and lead times
- *Lean* – Characteristics are:
  - Integration upstream with suppliers
  - Integration downstream with customers
  - High emphasis on efficiency
  - Aims for minimum stock holding
- *Agile* – Noted for flexibility and speed in coping with innovative products and unpredictable demand.

Although many supply chains will be a hybrid of models, it is important to understand the differences and the application of each model and application whether pure or hybrid. The traditional supply chain model has been covered in various chapters of this book, this chapter will primarily cover lean and agile models.

The organization of this chapter is:

- The origin of lean
- The tools of a lean supply chain
- The characteristics of a lean supply chain
- The characteristics of an agile supply chain
- The strategy of a lean and agile supply chain

The origin of lean

As with all facets of the quality movement, the origin of Lean enterprises is in manufacturing. Lean enterprise philosophy, and make no mistake, Lean is more than a system it is a philosophy, began with Japanese automobile manufacturing in the 1960s, and was popularized by Womack et al. in *The Machine that Changed The World* (1990). *The Machine that Changed the World* is essentially the story of the Toyota way of manufacturing automobiles. Up until then the manufacturing of automobiles had changed very little since Henry Ford in 1913 adapted the conveyor belt for manufacturing cars. Prior to Henry Ford's assembly line the automobile had been a luxury item hand made by a group of workers in a stationary workplace. Ford's conveyor belt (the assembly line) approach was for production to take place on a moving belt with each worker doing a small specialized task. Ford believed that if each step of production was broken down to the smallest element that 'the stupidest man could become a specialist in two days'. With this moving conveyor belt approach Ford was able to produce 250,000 cars a year, which sold at $500 each. The car from being a luxury item that only the rich could afford now became in effect a consumer item within the reach of most families. The downside was the minute division of labour and the cyclical nature of the work, and the inexorable pace of the moving conveyor belt. Workers lost a sense of the purpose of what they were doing, they could not see that they were building cars, they saw a repetitive mindless task such as putting bolts on a component as it moved past them. 'The assembly line is no place to work, I can tell you. There is nothing more discouraging than having a barrel beside you with 10,000 bolts in it and using them all up. Then you get another 10,000 bolts and you know that everyone of those bolts has to be picked up and put in exactly the same place as the last 10,000 bolts.' Walker, and Guest (1952). Chrysler, and General Motors and other manufacturers soon adopted the assembly line approach, but whereas Ford only had one model (the model 'T') the others led by General Motors and Chrysler began offering several models in the 1920s. Ford had to follow suit and to do so had to cease production for 7 months while new models were rushed into production. The assembly line approach was still used and models were made in batches, changing a model required set-up time for change of dies, etc. Work at each stage of production was still broken down to the lowest level, workers were not expected to think and there was a heavy reliance on inspection and testing to maintain a standard of finished product. The next major change in car manufacturing is credited to Ohno Taiichi of Toyota. Ohno Taiichi, after visiting USA car manufacturers in the 1960s, returned to Japan and developed a new method of manufacturing, which became known as lean production.

The Lean Manufacturing, sometimes referred to as Toyotaism or Toyota Production System, is that materials flow 'like water' from the supplier through the production process onto the customer with little if any stock of raw materials or components in warehouses, no buffer stocks of materials and part-finished goods between stages of the manufacturing process, and no output stock of finished goods. This 'just-in-time' (JIT) approach requires that materials arrive from dedicated suppliers on the factory floor at the right stage of production just when required, and when the production process is completed it is shipped directly to the customer. With no spare or safety stock in the system there is no room for error. Scheduling of activities and resource has to be exact, communication with suppliers must be precise, suppliers have to be reliable and able to perform to exacting timetables, materials have to arrive on time and meet the specification, machines have to be maintained so that there is no down time, operators cannot make mistakes, there is no allowance for scrap or rework and finally the finished product has to be delivered on time to customers. This is often implemented by circulating cards or Kanban between a workstation and the downstream buffer. The workstation must have a card before it can start an operation. It can pick raw materials out of its upstream (or input) buffer, perform the operation, attach the card to the finished part, and put it into the downstream (or output) buffer. The card is circulated back to the upstream to signal the next upstream workstation to do next cycle. The number of cards circulating determines the total buffer size. Kanban control ensures that parts are made only in response to a demand.

This 'just-in-time' approach generally precludes large batch production; instead items are made in 'batches' of one. This means that operators have to be flexible, the system has to be flexible and 'single minute exchange of dies' (SMED) becomes the norm. A lean approach reduces the number of supervisors and quality inspectors. The operators are trained to know the production standards required and are authorized to take corrective action, in short they become their own inspectors/supervisors. The principles of TPM (Total Productive Maintenance) and Five Ss (Sort, Set in place, Shine, Standardize and Sustain) are followed and as a result the equipment becomes more reliable and the operator develops 'ownership' towards the equipment.

Another important aspect of the Toyota approach was to expand the work done at each stage of production. For example, a team of workers will be responsible for a stage of production or 'Work Cell' on the moving assembly line, such as installing the transmission, or installing the seats, etc. Each team is responsible for it is part of the assembly and might be able to make minor changes to procedures within the confines of a time limit (the time allowed on the moving line for production to move from one stage to the next) and within the limits of the specified standards (for example, the team can change the order of assembly at their workstation but would not have the authority to add extra nuts, etc.). Quality standards are assured the application of Zero Quality Control or Quality at Source before the actual production and Poka Yoke (mistake proofing) during a production process.

A visitor to a Lean manufacturer will be struck by the lack of materials; there is no warehouse, no stocks of materials between workstations, and no stocks of finished goods. At first glance this suggests that Lean is an inventory system. But Lean is not just an inventory system, Lean also means the elimination of 'muda'. Muda, is a Japanese word, which means waste, with waste being defined as any human activity that absorbs resource but creates no value. Thus, the philosophy of Lean is the elimination of non-value adding activities. The rough rule is the elimination of any activity that does not add value to the final product, and the taking of action so that the non-value activity never again occurs.

Before anything can be eliminated it first has to be identified. The Toyota approach to identifying areas of waste is to classify waste into seven 'mudas'.

The seven 'mudas' are:

- Excess production
- Waiting
- Movement or transportation
- Unnecessary motion
- Non-essential process
- Inventory
- Defects

The approach is to identify waste, find the cause, eliminate the cause, make improvements and standardize (until further improvements are found).

The tools of lean supply chain

The original Toyota model of Lean Manufacturing, from which various hybrids were developed, comprised eight tools and approaches:

1. TPM
2. Five Ss: These represent a set of Japanese words for excellent house keeping (Seiri – Sort, Seiton – Set in place, Seiso – Shine, Seiketso – Standardize and Shitsuke – Sustain).
3. JIT
4. SMED
5. Jidoka or Zero Quality Control
6. Production Work Cells
7. Kanban
8. Poka Yoke

The methodology of lean thinking and lean supply chain has moved on since Toyota's Lean Manufacturing model and embraced additional tools and approaches. We have therefore included two more:

9. Value stream and process mapping
10. Lean Sigma and FIT SIGMA

Glossary of lean tools

A brief description of frequently used tools and approaches in lean supply chain is given below. For further details please see:

- *Implementing Quality* (Basu, 2004)
- *Quality Beyond Six Sigma* (Basu and Wright, 2003)

TPM: In TPM, operators are enlisted in the design, selection, correction and maintenance of equipment so that every machine or process is always able to perform its required tasks without interrupting or slowing down defect-free production.

Five Ss: The five rules of good housekeeping – sort, set in place, shine, standardize and sustain.

JIT: It is an inventory strategy implemented to improve the return on investment of a business by reducing in-process inventory and its associated costs.

- *Single minute exchange of die (SMED)*: Operator techniques pioneered by Shigeo Shingo, a Japanese industrial engineer, that result in changeovers of production machinery in less than 10 minutes.
- *Zero Quality Control (Jidoka)*: The transfer of human intelligence to automated machinery so that machines are able to stop, start, load and unload automatically, detect when a defective part has been produced, stop themselves and signal for help. This means operators are freed up to do value adding work. (The practitioners of Japanese martial art Judo are called Judoka. Six Sigma also adopted terms like Black Belt and Green Belt from Japanese martial art.)
- *Production Work Cells*: At Toyota, the work done at each stage of production was expanded, so that a team of workers is responsible for a stage of production, and has the power to be able to make minor changes to procedures within the confines of a time limit and standards. The autonomy of operators is in direct contrast to Ford's production line drones. Lending power to the workers so they could take corrective action meant that there was less need for inspectors to stop mistakes.

- *Kanban*: Kanban cards ensures that parts are only made in response to demand – each workstation must have a card before it can start an operation.
- *Mistake proofing (Poka Yoke)*: A procedure that prevents defects or malfunction during manufacture by, for example, eliminating choices that lead to incorrect actions; stop a process if an error is made; prevent machine damage.

Value steam and process mapping: Process mapping is a tool to represent a process by a diagram containing a series of linked tasks or activities which produce an output. Value stream mapping is a high level process mapping to show the total operation or business and identify 'mudas'.

Takt Time is the pace of production needed to meet customer demand. It is the average rate at which customers buy products and hence the rate at which products should be manufactured. It is expressed in time units – one every so many minutes or so many minutes between completions:

$$\text{Takt Time} = \frac{\text{Available work time}}{\text{Customer demand}}$$

Lean Sigma and FIT SIGMA: Lean Sigma incorporates the principals of JIT and now relates to the supply chain from supplier and supplier's supplier, through the process to the customer and the customer's customer. FIT SIGMA incorporates all the advantages and tools of TQM (total quality management), Six Sigma and Lean Sigma. The aim is to get an organization healthy (fit) by using appropriate tools for the size and nature of the business (fitness for purpose) and to sustain a level of fitness.

The characteristics of lean supply chain

The characteristics and tenets of a lean supply chain are derived from the principles of Toyota Production Systems (TPS) and the methodology of Lean Sigma. Womack, Jones and Roos (1990) proposed five Lean principles based on TPS, viz. value, value stream, flow, pull and perfection. However, the application of Lean principles has moved with time and experience of organizations in both manufacturing and service sectors. Until recently supply chains were understood primarily in terms of planning the demand forecasts, upstream collaboration with suppliers and planning and scheduling the resources. Emphasis perhaps is shifted to provide what the customers want at a best in class cost. Cost reduction is often the key driver for lean, but it is also about speed of delivery and quality of products and services. The competition for gaining and retaining customers and market share is between supply chains rather than other functions of companies. A supply chain therefore has to be lean with four inter-related key characteristics or objectives:

1. Elimination of waste
2. Smooth operation flow
3. High level of efficiency
4. Quality assurance

Elimination of waste

The lean methodology as laid out by Womack, Jones and Roos (1990) is sharply focussed on the identification and elimination of 'mudas' or waste and their first two principles (i.e. value and value stream) are centred around the elimination of waste. Their motto has been, 'banish waste and create wealth in your organization'. It starts with value stream mapping to identify value and then identify waste with process mapping of valued processes and then systematically eliminate them. This emphasis on waste elimination has probably made lean synonymous to absence of waste. Waste reduction is often a good place to start in the overall effort to create a lean supply chain because it can often be done with little or no capital investment.

One popular area of waste in processes is excess inventory. Many organizations started to measure their 'leanness' only in terms of inventory performance. Inventory reduction attempts to reduce inventory through such practices as enterprise resource planning (ERP), JIT and modern approaches to supply chain management have led to lower inventory levels, but there is still plenty of room for improvement. In fact, most all manufacturers carry at least 25 per cent more inventory than they have to. The techniques of inventory management and reduction have been covered in Chapter 7. This inventory centred approach seems to be encouraged by *Leanness Studies* (Schonberger, 2003). In these annual study reports, Schonberger measured the trends in inventory turnover (annual cost of goods divided by value of inventory) and then graded and ranked the companies according to inventory performance. This approach although is a good indicator of inventory policy of a company, but it does not necessarily reflect the business performance of the company. For example, the inventory policy of a fast-moving consumer goods (FMCGs) company is different from that of a pharmaceutical company. Inventory is only one of the seven 'mudas'.

Cycle time or lead-time reduction is another target area of waste reduction. Cycle time is the time required to complete a given process. The cycle time required to process a customer order might start with the customer phone call and end with the order being shipped. The overall process is made up of many sub-processes such as order entry, assembly, inspection, packaging and shipping. Cycle time reduction is identifying and implementing more efficient ways of completing the operation. Reducing cycle time requires eliminating or reducing non-value-added activity. Examples of non-value-added activity in which cycle time can be reduced or eliminated include repair due to defects, machine set-up, inspection, waiting for approval, test and schedule delays.

There are a few formal and publicized methodologies for cycle time reduction including QRM (Quick Response Manufacturing; Suri, 1998) and SMED (Single Minute Exchange of Dies; Shingo, 1985). QRM is underpinned by two key principles. First, plan to operate at 80 per cent or even 70 per cent capacity of critical resources. Second, measure the reduction of lead times and make this the main performance measure. These principles are supported by material requirements planning (MRP) plans for production-oriented cells and continuous training. The SMED method involves the reduction of production changeover by extensive work study of the changeover process and identifying the 'in process' and 'out of process' activities and then systematically improving the planning, tooling and operations of the changeover process (see Figure 13.1). Shingo believes in looking for simple solutions rather than relying on technology. With due respect to the success of the SMED method, it is fair to point out that the basic principles are fundamentally the application of classical industrial engineering or work study.

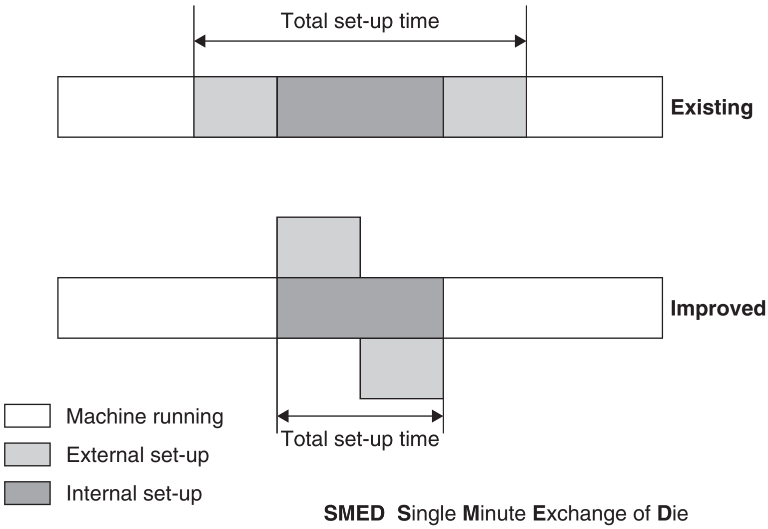

Figure 13.1 Set-up time reduction.
Source: Basu and Wright, Total Manufacturing Solutions (1997).

The reduction of cycle time has become an important feature of lean thinking beyond manufacturing industries where approaches other than QRM and SMED are applied. In service industries such as call centres there has extensive application of value analysis around process mapping charts. Even flow production technique (Ballard, 2001) is applied in reducing cycle time in the construction of repetitive residential homes. The technique comprises: (1) overlap activities within their phase of the work, (2) reduce activity durations through cycle time studies and (3) reduce work in process through the development of multi-skilled workers. Cycle time reduction is also an important area of Lean Sigma projects as illustrated by the following case example.

Case example: Cycle time reduction

Platinum catalyst is used for production of an active pharmaceutical ingredient (API) in an Eastern European Pharmaceutical Company (henceforth referred as 'company'). Used catalyst is sent back to supplier who recovers platinum and uses it for production of fresh catalysts. During that cycle certain quantity of catalyst evanesces and new quantity has to be purchased periodically to maintain required level of inventory. The catalyst is expensive because of platinum and the related cost of capital for required catalyst inventory is significant. A task team led by a Six Sigma Black Belt was formed to reduce the cycle time of procuring the platinum catalyst.

Catalyst inventory required for normal production of the API depends on catalyst consumption in production and catalyst regeneration cycle time. Time required for cycle of regeneration of catalyst (platinum recovery and new catalyst production) was about 3 months. During that period it was necessary to have enough catalyst in possession for normal production. Since significant improvements in the production of the API were already achieved in reducing catalyst consumption, the scope of the project included only activities related to the reduction of regeneration cycle time.

For the monitored period the mean regeneration times depending on the supplier varied between 77 and 69 days (year 2003) and during the year 2004 values were marginally better than the year before. During the year 2004 significantly better results were achieved also for the transport time and the average transport time was 5 ± 2 days what was acceptable.

Transport time had relatively less influence on overall cycle time. Still and it was important to minimize mistake opportunities during the transport. This was assured by proper planning (sales, production, purchasing and distribution), regular communication (all interested parties) and using only reliable and proved carrier and forwarder. Addition to that all transport details were carefully specified and agreed, transport of catalyst always had high priority (because of high value of shipment) and the company always had proper information about shipment status during the transport.

The biggest influence on overall cycle time was the regeneration of catalyst. This was clearly the supplier's responsibility and the company could not directly influence that process. The regeneration time specified in contract between the company and each supplier was 10 weeks for one mayor supplier and 11 weeks for another for year 2004.

After brainstorming the team identified only two possible solutions:

- To ask each approved supplier to prepare offer for year 2005 with maximum regeneration time of 8 weeks.
- To find and develop new supplier for catalyst who can fulfil our request.

Although the company developed four new suppliers for the platinum catalyst, only two of them were reliable and another two could not achieve required quality each time. Another problem was that the specification for catalyst was quite general and earlier analysis could not properly represent the regulated quality of the catalyst. Consequently, the development of approved new suppliers took a long time. Minimum regeneration time achieved in the past was 8 weeks and 6 days and because of all that the team decided to ask each of qualified suppliers to regenerate catalyst within 8 weeks and the team prepared negotiation strategy for that.

To test supplier's ability to fulfil new requirement, the company asked each of the supplier to deliver next shipments of regenerated catalyst till the end of the year 2004 within 9 weeks instead 11 (including transport). One of the approved suppliers answered positively but asked for some adjustment in packaging of spent catalyst which did not require additional cost, that allowed the company not to buy new quantity of 1.000 kilograms of fresh platinum catalyst and generated a saving in cost of capital of US $20,000 in last 3 months of the year 2004.

Negotiations with key suppliers for platinum catalyst finished successfully and resulted with new contracts where maximum regeneration time is 8 weeks. New contract with one of them was signed on February 2005, and with another one on March 2005.

New contract with supplier is a powerful tool for sustaining of new agreed platinum catalyst regeneration performance, and performance in the year 2005 is better than promised. All involved in platinum catalyst handling were educated against that standard operating procedure.

Both of these improvements cycle time was reduced by 30 per cent and the inventory of the catalyst reduced from 7.728 to 4.500 kilograms. The overall annual savings related to avoidance of cost of capital needed for buying of new quantity of catalyst was $408,615 per annum.

Smooth operational flow

The well publicized JIT approach is a key driver of Lean Supply Chain and, as we have indicated earlier, it requires materials and products flow 'like water' from the supplier through the production process onto the customer. The capacity bottlenecks are eliminated, the process times of workstations are balanced, and there is little buffer inventories between operations. Smooth operation flow requires the applications of appropriate approaches. Three of the most frequently applied approached are:

1. Cellular manufacturing
2. Kanban pull system
3. Theory of constraints (TOC)

In cellular manufacturing concept, traditional batch production area is transformed into flow line layouts so that ideally a single piece flows through the line at any time. In practice an optimum batch size is calculated starting with the most critical work centres and the largest inventory carrying costs. Action is taken for improvement at the work centres and methods that have greatest impact on the throughput, customer satisfaction, operating cost and inventory carrying charges. Good management consists of avoiding a wide variety of products. Cellular manufacturing concept is most appropriate when demand is predictable and products have low variety and high volume.

The Toyota Motor Company of Japan pioneered the Kanban technique in the 1980s. As part of Lean Manufacturing concepts Kanban was promoted as one of the primary tools of JIT concepts by both Taiichi Ohno (1988) and Shingo (1988). Inspired by this technique, American supermarkets in particular replenished shelves as they were emptied and thus reduced the number of storage spaces and inventory levels. With a varied degree of success outside Japan, Kanban has been applied to maintain an orderly flow of goods, materials and information throughout the entire operation.

Kanban literally means 'card'. It is usually a printed card in a transparent plastic cover that contains specific information regarding part number and quantity. It is a means of pulling parts and products through the manufacturing or logistics sequence as needed. It is therefore sometimes referred to as the 'pull system'. The variants of the Kanban system utilize other markers such as light, electronic signals, voice command or even hand signals.

Following the Japanese examples, Kanban is accepted as a way of maximising continuous flow and efficiency by reducing both cost and inventory.

The key components of a Kanban system are:

- Kanban cards
- Standard containers or bins
- Workstations, usually a machine or a worktable
- Input and output areas

The input and output areas exist side by side for each workstation on the shop floor. The Kanban cards are attached to standard containers. These cards are used to withdraw additional parts from the preceding workstation to replace the ones that are used. When a full container reaches the last downstream workstation, the card is switched to an empty container. This empty container and the card are then sent to the first workstation signalling that more parts are needed for its operation.

A Kanban system may use either a single card or a two cards (move and production) system. The dual card system works well in a high up-time process for simpler products with well-trained operators. A single card system is more appropriate in a batch process with a higher changeover time and has the advantage of being simpler to operate. The single card system is also known as 'Withdrawal Kanban' and the dual card system is sometimes called 'Production Kanban'.

The system has been modified in many applications and in some facilities although it is known as a Kanban system, the card itself does not exist. In some cases the empty position on the input or output areas is sufficient to indicate that the next container is needed.

Case example: Kanban pull system

The following example is based on the experience of Level Industrial, the Brazil subsidiary of Unilever in Sao Paulo.

Lever Industrial was engaged in the batch production of industrial detergents comprising nearly 300 stock keeping units (SKUs) which varied from a 500 kilograms draw to a 200 grams bottle. After carrying out a Pareto analysis the team selected three fast-moving products for a pilot Kanban system. These products in total accounted for 18 per cent of output.

The company adopted for each product, a simple single card Kanban system consisting of five stages as shown below (Figure 13.2).

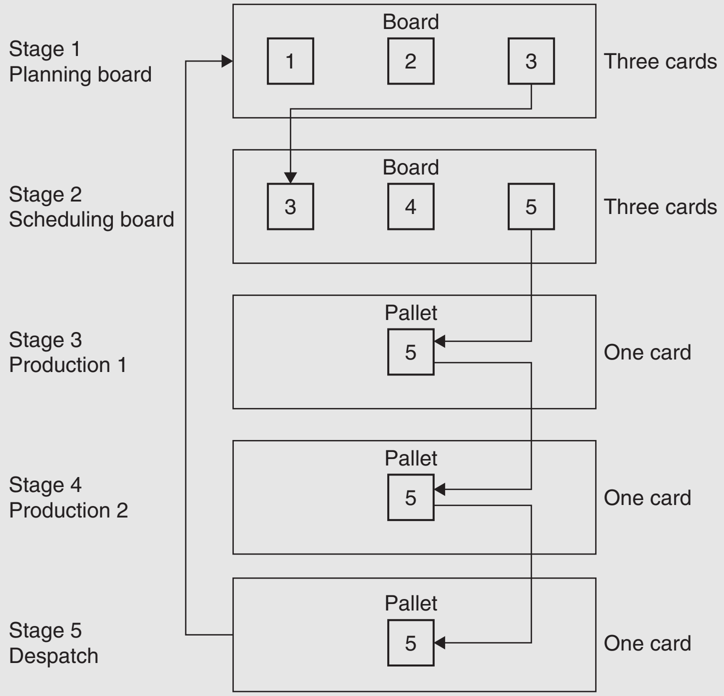

Figure 13.2 Kanban system.

Both the planning board and the scheduling board contain three cards each as a buffer between the variability of production cycle time and the availability of materials.

When the card arrives from the despatch (Stage 5) it is kept on the planning board and planning for the product starts. When the planning board is full with three cards, the third card is passed to the scheduling board and production scheduling is ensured. Similarly when the scheduling board is full, the third card is transferred to the pallet at the Production Station 1 and actual production begins.

When the pallet in Stage 3 (Production 1) is full, the card then moves to the next station (Production 2) in Stage 4, and then on to despatch in Stage 5. After the goods are despatched, the card returns to the planning board and the next cycle begins.

The pilot exercise was successful. It achieved an improvement in customer service which rose from 84 per cent to an excellent 98 per cent and inventory was also reduced. The Kanban system was extended to nine additional key products. The manual system was retained for the above five stages, although both the planning and stock adjustment processes were supported by MFG-Pro, the ERP system.

The Theory of Constraints (TOC) is a management philosophy developed by Goldratt (1992). It enables the managers of a system to achieve more of the goal that system is designed to produce. The concept or the objective is not new. However, in service operations where it is often difficult to quantify the capacity constraint TOC could be very useful. For companies that employ skilled workers and for many service organizations the constraint is often the time of one or a few key employees. The key steps in this process are:

1. *Identify*: The first step in applying TOC is to identify the constraining or bottleneck factor.
2. *Exploit*: Determine the throughput per unit of the constraining factor.
3. *Subordinate*: Prevent the resources needed from waiting in a queue at a non-constrained resource.
4. *Elevate*: If it still cannot produce enough products to produce demand, find ways to increase capacity.
5. Go back to step 1.

Implementation TOC, although simple in principle, is often difficult because it may require a complete change in the way a company operates. For example, TOC requires a shift from cost-based decision making to decision-making based on continuous improvement.

The smooth operation flow of materials and products are further enhanced by Lean Sigma methodology where the variances within processes and between workstations are minimized by the statistical techniques of Statistical Process Control (see Basu, 2004, pp. 151–157).

High level of efficiency

The more popular concepts of lean operations tend to be the concepts of muda, flow and pull system. A preliminary analysis of all these methods, as we have described earlier, however, highlights the fact that all assume sufficient machine availability exists as a prerequisite. In our experience for many companies attempting a lean transformation this assumption is not true. Machine availability depends on maximizing the machine up time by eliminating the root causes of down time. The ratio of up time and planned operation time is the efficiency of the operation. Therefore, in order to make lean concepts work it is vital that the pre-condition of running the operations at a high level of efficiency should be met. The old approach of measuring labour efficiency (e.g. the ratio of standard hours and hours worked) has now shifted to the efficiency of the control or bottleneck workstation.

There are many methodologies and tools of ensuring a high level of efficiency in a lean supply chain. We are going to describe one such methodology (viz. TPM) and two such tools (e.g. overall equipment effectiveness (OEE) and Five Ss).

Total Preventative Maintenance (TPM) is a proven Japanese approach to maximizing overall equipment effectiveness (OEE) and utilization, and relies on attention to detail in all aspects of manufacturing. TPM includes the operators looking after their own maintenance and thus encourages the empowerment. The use of the word 'maintenance' in the title is misleading. TPM includes more than maintenance, it addresses all aspects of manufacturing. The two primary goals of TPM are to develop optimum conditions for the factory through a self-help people/machine system culture and to improve the overall quality of the workplace. It involves every employee in the factory. Implementation requires several years, and success relies on sustained management commitment. TPM is promoted throughout the world by the Japan Institute of Plant Maintenance (JIPM).

TPM is the manufacturing arm of TQM and is based on five key principles:

1. The improvement of manufacturing efficiency by the elimination of six big losses.
2. The establishment of a system of autonomous maintenance by operators working in small groups.
3. An effective planned maintenance system by expert engineers.
4. A training system for increasing the skill and knowledge level of all permanent employees.
5. A system of maintenance prevention where engineers work closely with suppliers to specify and design equipment which requires less maintenance.

TPM requires the manufacturing team to improve asset utilization and manufacturing costs by the systematic study and the elimination of the major obstacles to efficiency. In TPM these are called the 'six big losses' and are attributed to (i) breakdown, (ii) set-up and adjustment, (iii) minor stoppages, (iv) reduced speed, (v) quality defects and (vi) start-up and shut-down.

The process of autonomous maintenance is to encourage operators to care for their equipment by performing daily checks, cleaning, lubrication, adjustments, size changes, simple repairs and the early detection of abnormalities. It is a step-by-step approach to bring the equipment at least to its original condition.

Some managers may hold the belief that in TPM 'you do not need experienced craftsmen or engineers and all maintenance is done by operators'. This is not true. The implementation of a maintenance policy with appropriate infrastructure is fundamental to planned maintenance. Planned maintenance is the foundation stone of TPM. However, if the skill and education levels of operators are high then a good proportion of planned maintenance activities should be executed by operators after proper training. Cleaning, lubrication and minor adjustments together with an ability to recognize when a machine is not functioning correctly should be the minimum which is required of operators.

For TPM to succeed a structural training programme must be undertaken in parallel with the stages of TPM implementation. In addition, 'one point lessons' can be used to fill in a specific knowledge gap. This uses a chart which is displayed at the workplace and describes a single piece of equipment and its setting or repair method.

Whilst great progress can be made in reducing breakdowns with autonomous maintenance and planned maintenance, 'zero breakdowns' can only be achieved by the specification of parts and equipment which are designed to give full functionality and not to fail. All engineers and designers of the user company should work concurrently with the suppliers of equipment to achieve a system of maintenance prevention.

Although there is a special emphasis of input by different employees to different aspects of TPM (e.g. 'six big losses' for middle management, 'autonomous maintenance' for operators, 'planned maintenance' for middle management, 'maintenance prevention' for senior management), TPM involves all employees and the total involvement is ensured by establishing TPM work groups or committees. Figure 13.3 illustrates an example of a TPM organization.

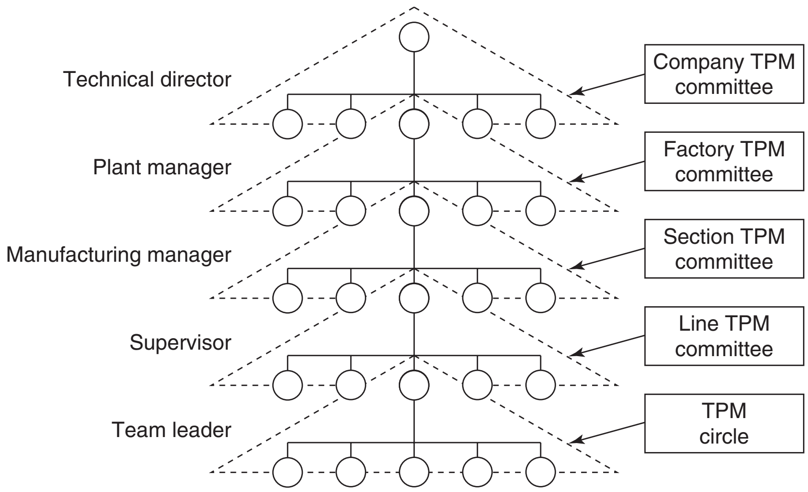

Figure 13.3 TPM organization.

To summarize, TPM is a factory-wide continuous improvement programme with particular emphasis on changing the culture of the shop floor through improved attitudes and skills. TPM progress is measured by the stages of autonomous maintenance completed, and visible progress is also seen in the higher reliability of equipment, reduction of waste and improvements in safety statistics.

Case example: TPM at Nippon Lever, Japan

Background

The Utsunomia plant in Japan was commissioned in 1991 on a green-field site by Nippon Lever to manufacture household detergents products and plastic bottles for liquid detergents. The factory was experiencing 'teething' problems primarily due to the poor reliability and lack of local support of the imported equipment. Many of the employees were new to factory work.

To improve this situation the company used the help of the JIPM, an organization which is working on TPM with over 800 companies in Japan. TPM has been widely used in Japan, having been developed to support Lean/JIT and TQM. It was considered to be appropriate for the Utsunomiya plant TPM focuses on machine performance and concentrates on operator training and teamwork.

Approach

A TPM programme was launched at the Utsunomiya plant in July 1992 with the objective of zero losses:

- zero stoppages
- zero quality defects
- zero waste in materials and manpower

Strong organizational support was provided by the Nippon Lever management in terms of:

- a top management steering team to facilitate implementation by removing obstacles;
- a manager to work full time supporting the programme;
- one shift per week set aside for TPM work;
- training for managers, leaders and operators involving JIPM video training material.

The programme launch was initiated at a 'kick-off' ceremony in presence of the whole Nippon Lever Board and managers from other company and suppliers' sites.

Implementation
The initial thrust of the programme was the implementation of 'autonomous maintenance' following the JIPM's seven steps:

1. Initial cleanup
2. Elimination of contamination
3. Standard setting for operators
4. Skill development for inspection
5. Autonomous inspection
6. Orderliness and tidiness
7. All-out autonomous working

To implement the seven steps, 'model machines' (those giving the biggest problems) were chosen. This approach helps to develop operators' knowledge of a machine and ensures that work on the model can be used as the standard for work on other machines. It also helps motivation. In that if the worst machine moves to the highest efficiency, this sets the tone for the rest of the process.

The improvements to the machines were made using Kaizen methodology (small incremental improvements), and were carried out by groups of operators under their own guidance. Two means of support were given to operators – a Kaizen budget per line so that small repairs and capital expenses could be agreed without delay and the external JIPM facilitator provided encouragement and experience to workgroups.

Results and learning points
By the end of 1993, substantial benefits were achieved within a year at the Utsunomiya plant including:

- £2.8 million reduction in operating costs;
- reduced need for expensive third-party bottles;
- production efficiency increased from 54 to 64 per cent for high speed soap lines and from 63 to 80 per cent for liquid filling lines;
- a team of trained, motivated and empowered operators capable of carrying out running maintenance.

The success of the programme at the Utsunomiya plant led to the introduction of TPM to other two factories of Nippon Liver (Shimizu and Sagamihara). Over the next few years the Corporate Groups of Unilever encouraged all sites outside Japan to implement TPM with remarkable successes achieved particularly in factories in Indonesia, Brazil, Chile, UK and Germany.

Tools and techniques used
OEE, Five S, Five Why, Kaizen, SMED

Source: Leading Manufacturing Practices, Unilever Research and Engineering Division (1994)

The Overall Equipment Effectiveness (OEE) is an index of measuring the delivered performance of a plant or equipment based on good output.

The method of monitoring OEE is devised in such a way that it would highlight the losses and deficiencies incurred during the operation of the plant and identify the opportunities for improvement.

There are many ways to calculate OEE (see Hartman, 1991; Shirose, 1992). In this section, we describe the methodology of OEE that was developed and applied by Ron Basu in both Unilever[1] and GlaxoWellcome.[2]

OEE is defined by the following formula:

$$\text{OEE \%} = \frac{\text{Actual good output}}{\text{Specified output}} \times 100$$

where specified output = specified speed × operation time

The application of OEE has been extensive, especially when driven by the TPM programmes, to critical plant and equipment. It can be applied to a single equipment, a packing line, a production plant or processes. In order to appreciate the usefulness of OEE it is important to understand equipment time analysis as shown in Figure 13.4 and described below.

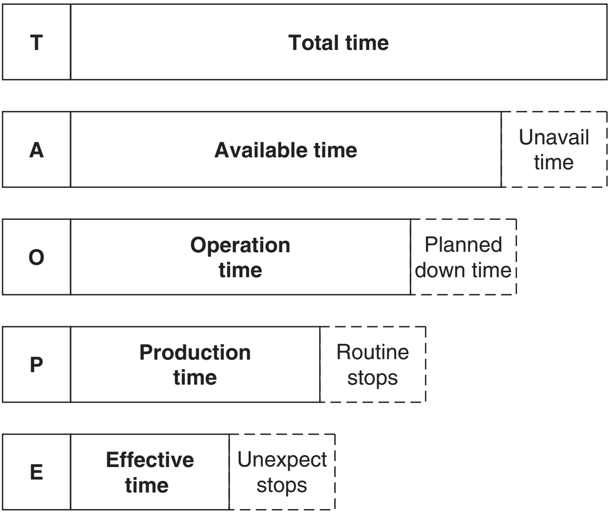

Figure 13.4 Equipment time analysis.

Total time defines the maximum time within a reporting period, such as 52 weeks a year, 24 hours a day, 8760 hours in a year.

Available time is the time during which the machine or equipment could be operated within the limits of national or local statutes, regulation or convention.

[1]In Unilever Plc, the methodology was known as PAMCO (Plant and Machine Control).

[2]In GlaxoWellcome it was called CAPRO (Capacity Analysis of Production).

Operation time is the time during which the machine or equipment is planned to run for production purposes. The operational time is normally the shift hours.

Production time is the maximum time during which the machine or equipment could be expected to be operated productively after adjusting the operation time for routine stoppages such as changeover and meal breaks.

Effective time is the time needed to produce a 'good output delivered' if the machine or equipment is working at its specified speed for a defined period. It includes no allowances for interruptions or any other time losses.

It is important to note that effective time is not recorded, it is calculated from the specified speed as:

$$\text{Effective time} = \frac{\text{Good output}}{\text{Specified speed}}$$

where specified speed is the optimum speed of a machine or equipment for a particular product without any allowances for loss of efficiency. It is expressed as quantity per unit such as tonnes per hour, bottles per minute, cases per hour or litres per minute.

In addition to OEE, two other indices are commonly used as shown below:

$$\text{Production efficiency (\%)} = \frac{\text{Effective time } (E)}{\text{Production time } (P)} \times 100$$

$$\text{Operational Utilisation (\%)} = \frac{\text{Operation time } (O)}{\text{Total time } (T)} \times 100$$

A properly designed and administered OEE scheme offers a broad range of benefits and a comprehensive manufacturing performance system. Some of its key benefits are:

- It provides information for shortening lead time and changeover time and a foundation for SMED.
- It provides essential and reliable data for capacity planning and scheduling.
- It identifies the 'six big losses' of TPM leading to a sustainable improvement of plant reliability.

Case example: OEE of ACMA soap wrapping machine

Consider the production data of a toilet soap packing line where the control station governing the specified speed is an ACMA 711 wrapping machine.

Week Number	31
Operation time	128 hours
Specified speed	150 tablets per minute

Good output	4232 cases
Routine stoppages	11 hours 30 minutes
Unexpected stoppages	27 hours 15 minutes

Given that each case contains 144 tablets,
Good output = 4232 × 144 = 609,408 tablets

$$\text{Effective time} = \frac{\text{Good output}}{\text{Specified speed}} = \frac{609,408}{150 \times 60} = 67.71 \text{ hours}$$

Production time = Operation time − Routine stoppages
= 128 − 11.5 = 116.5 hours
Total time = 7 × 24 = 168 hours

$$\text{OEE} = \frac{\text{Effective time}}{\text{Production time}} = \frac{67.71}{128} = 0.53 = 53\%$$

$$\text{Production efficiency} = \frac{\text{Effective time}}{\text{Production time}} = \frac{67.71}{116.5} = 58\%$$

$$\text{Operation utilization} = \frac{\text{Operation time}}{\text{Total time}} = \frac{128}{168} = 76\%$$

It is important to note that the effective time was calculated and not derived from the recorded stoppages. There will be an amount of unrecorded time (also known as time adjustment) as, in the example, given by
Unrecorded time = (Production time − Unexpected stoppages) − Effective time
= (116.5 − 27.25) − 67.71
= 21.54 hours

- It provides information for improving asset utilization and thus reduced capital and depreciation costs in the longer term.

Five S is a tool for improving the housekeeping of an operation, developed in Japan, where the Five Ss represent five Japanese words all beginning with 's':

- *Seiri (organization)*: Separate what is essential from what is not.
- *Seiton (neatness)*: Sort and arrange the required items in an orderly manner and in a clearly marked space.
- *Seiso (cleaning)*: Keep the workstation and the surrounding area clean and tidy.
- *Seiketson (standardization)*: Clean the equipment according to laid down standards.
- *Shitsuke (discipline)*: Follow the established procedure.

In order to retain the name ‘Five S’, a number of English language versions have evolved. These include:

- *Seiri*: Sort
- *Seiton*: Set in order/Stabilize
- *Seiso*: Shine
- *Seiketsu*: Standardize
- *Shitsuke*: Sustain

The Five S method is a structured sequential programme to improve workplace organization and standardization. Five S improves the safety, efficiency and the orderliness of the process and establishes a sense of ownership within the team.

Five S is used in organizations engaged in Lean Sigma, JIT, TPM and TQM. This principle is widely applicable not just for the shop floor, but for the office too. As an additional bonus there are benefits to be found in environmental and safety factors due to the resulting reduced clutter. Quality is improved by better organization and productivity is increased due to the decreased time spent in searching for the right tool or material at the workstation. Consider the basic principle of a parent tidying a small child’s room which is overflowing with clutter and sorting together various types of toys. The end product should be a neater, warmer, brighter and more civilized play environment which will encourage the child to utilize all toys and equipment more productively because all relevant pieces are together, space is enhanced and mess is reduced.

It is useful to note that the quality gurus of Japan like numbered lists, for example the Seven Mudas, the Five Whys, and the Five Ss. However, the exact number of Ss is less important than observing the simple doctrine of achieving the elimination of wastes.

As the Five S programme focuses on attaining visual order and visual control, it is also a key component of Visual Factory Management. As Five S is primarily a visual process, a good example of promoting its message would be to display pictures of a workplace with photographs showing both ‘before’ and ‘after’ depictions of the implementation of Five S.

Case example: Five S at Northrop Grumman Inc., USA

Northrop Grumman Corporation is a global defence company headquartered in Los Angeles and provides technologically advanced products, services and solutions in systems integration, defence electronics, advanced aircraft and space technology.

Northtrop Grumman first deployed Five S on a part delivery process. The work area assembled a variety of components into a single product.

Before Five S, the area was not well organized, and the process was inefficient. With Five S implementations, the area saw a huge 93 per cent reduction in the space employees travel to complete tasks as well as a

42 per cent reduction in the overall floor space and 20 per cent improvement in operational efficiency.

The system has become a one-piece flow operation between assembly and mechanics, enabling everyone involved to know what the station has and what it needs.

Source: Skinner (2001)

Quality assurance

Womack Jones and Roos (1990) propose perfection as the fifth Lean principle and according to this a lean manufacturer sets his/her targets for perfection in an incremental (Kaizen) path. The idea of TQM also is to systematically and continuously remove the root causes of poor quality from the production processes so that the organization as a whole and its products are moving towards perfection. This relentless pursuit of the perfect is key attitude of an organization that is 'going for lean'.

The incremental path to TQM progressively moves from earlier stages of quality control and quality assurance. Quality assurance focuses on the prevention of failures or defects in a process by analysing the root causes and sustaining the improved process by documenting the standard operating procedure and continuous training. TQM is quality assurance of all processes across the organization involving everyone from the top manager to a trainee. Therefore, the central driver towards perfection is quality assurance.

This drive for quality assurance has now been extended beyond TQM to Six Sigma with additional rigour in training deployment (e.g. Black Belts and Green Belts), the methodology of DMAIC (e.g. Define, Measure, Analyse, Improve and Control), and measurement (both variances and savings). The principles of Six Sigma are embedded in the path towards perfection in a lean supply chain and Six Sigma has now moved to Lean Sigma and FIT SIGMA. Basu and Wright (2003) explain that the predictable Six Sigma precisions combined with the speed and agility of Lean produces definitive solutions for better, faster and cheaper business processes. Through the systematic identification and eradication of non-value added activities, optimum value flow is achieved, cycle times are reduced and defects eliminated. The dramatic bottom line results and extensive training deployment of Six Sigma and Lean Sigma must be sustained with additional features for securing the longer-term competitive advantage of a company.

Case example: Lean supply chain in Seagate, USA

Background
Seagate Technology is the world's largest manufacturer of disc drives and HDD recording media. With its headquarters at Scotts Valley, California, the company employs 62,000 people and its turnover in 2000

exceeded $7 billion. The business operates in a market environment of short product life cycle and quick ramp to high volume. The data storage market is growing 10–20 per cent per year and the technology content doubles every 12 months. Volume products remain in production for only 6–9 months.

Approach

In 1998, Seagate's senior executive team was concerned that business performance was not on par with expectations and capabilities. The quality group was charged with recommending a new model or system with which to run the business. The Six Sigma methodology was selected and launched in 1998 to bring common tools, processes, language and statistical methodologies to Seagate as a means to design and develop robust products and processes. Six Sigma helps Seagate to make data-based decisions that maximize customer and shareholder value thus improving quality and customer satisfaction while providing bottom line savings.

Six Sigma was one of the three key activities seen as essential for Seagate's continuing prosperity. The other two were:

1. *Supply chain*: How to respond to demand changes in a timely manner, execute to commitments and provide flexibility to customers.
2. *Core teams*: How to manage product development from research not sure what you are saying hereto volume manufacture.

Implementation

Seagate Springtown (which is part of Seagate Recording) started a supply chain project to improve materials management and develop a strategic vendor relationship. The fabrication plan at Springtown introduced the Lean Manufacturing philosophy that recognizes waste as the primary driver of cycle time and product cost. Very soon a change had taken place at Springtown and Lean Manufacturing was wholly integrated with the supply chain initiative.

The corporate office at Scotts Valley was rolling out a global Six Sigma deployment programme. The Springtown site followed the Six Sigma training programme and implemented a number of tools and techniques including the process map, sampling plan, cause and effect analysis and control plans, which identified a 'hidden factory'. The less visible defects of this 'hidden factory' included:

- Repeated measurements (in and out)
- Repeated chains (post and pre)
- Transits between manufacturing areas
- Process steps conducted in 'non-standard operating conditions'
- High rework on a process

Results and learning points

The Six Sigma methodology proved a key enabler for supply chain /Lean Manufacturing and the integrated programme achieved improved process capability and quality as shown by:

- Increased throughput by 31 per cent
- Significant impact on capital expenditure due to increased efficiency of existing equipment
- Lower work in progress
- 80 per cent pass rate on qualifications for vacuum tools (previously 40 per cent)

The main learning points from the Six Sigma programme at Seagate Technology include:

1. Companies using Six Sigma need to learn how to use the metrics to manage – to make appropriate decisions on a holistic basis, avoiding sub-optimization. This task of integration with the whole of the company's business process is the key.
2. Set aggressive goals – do not make them too easy.
3. Develop a system for tracking 'soft savings'.
4. Develop a common language and encourage its use on a widespread basis early in the program.
5. Embed the business process within the organization by training all functions – use green, black belt and customized programs as appropriate.

Source: Basu (2004, p. 257)

The Toyota Production System is frequently modelled as a house with two pillars. One pillar represents JIT, and the other pillar, the concept of jidoka. Jidoka is 'automation with a human touch'. This is usually illustrated by example of a machine that will detect a problem and stop production automatically rather than continue to run and produce bad output. Jidoka principle contributes to the achievement of both high efficiency and sustainable quality assurance.

The principle was first used by Sakichi Toyoda at the beginning of the 20th century when he invented a loom which stopped when the thread broke. Jidoka comprises a four-step process that engages when abnormalities occur:

1. Detect the abnormality
2. Stop
3. Fix or correct the immediate condition
4. Investigate the root cause and install a countermeasure

The first two steps can be mechanized or automated. Poka-yoke method also allows a process to detect a problem and stop. Ultimately, it is about transferring human intelligence to machines to eradicate the problem.

The characteristics of an agile supply chain

In Chapter 3, we highlighted the distinction between a lean supply chain and an agile supply chain in concurrence with both Fisher (1997) and Christopher (2000).

Christopher (2000) defines agility as achieving a rapid response on a global scale to constantly changing markets. The rapid response needs to cover changes in demand for both volume and variety. A third dimension is lead times and how long it takes to replenish the goods in order to satisfy demand.

Agility is achieved by flexibility and in order to achieve flexibility standard platforms are postponed and components and modules are final assembled when the demand for volume and variety are known. The standardized components and modules enable minimum stock keeping of finished products while at the same time the late assembly makes mass customization possible with short lead times. Buffer capacity is maintained in order to satisfy the fluctuation of demand. The above described agile set-up demand that the full global supply chain is involved. The subassembly of components into modules can be done in a low-cost environment, where as the final assembly will often be done close to demand in order to localize the product. Christopher suggests four characteristics of a truly agile supply chain as (1) market sensitive capable of reading and responding to real demand, (2) virtual which is information based rather than inventory based, (3) process integration ensuring collaborative working between buyers and suppliers and (4) network committed to closer and responsive relationships with customers.

Fisher (1997) offers a similar view on agile and responsive supply chain based on predictable demand versus unpredictable, but also with the product component of functional versus innovative products. Functional products are like staples that can be bought at groceries and petrol stations satisfy basic needs and have a predictable demand with a long lifecycle and low profit margin. Innovative products on the other hand are like state of the art MP4 players or fashion clothes having a short life cycle, with higher profit margins but with very unpredictable demand. These distinctions are exemplified as the product life cycle for functional products is typically more than 2 years, but for innovative products it can be from 3 months to 1 year. The margin of error for forecasting for functional products is in the 10 per cent range, but for the innovative products it varies from 40 to 100 per cent. Based on the short lifecycle and the unpredictable demand and forecasting, innovate products need an agile supply chain. The agile supply chain is achieved by buffer capacity and buffer stocks.

Fischer further argues that it is critical that the right supply chain strategy is chosen in order to match the demand and the product, so that innovative products with a high margin are channelled trough a responsive supply chain.

The cost of the buffers in capacity and inventory will be offset by a higher margin and the lower number of goods needed to be sold. The agile supply chain is achieved, according to Fischer, by adopting four rules, such as (1) accept that uncertainty is inherent in innovative products, (2) reduce uncertainty by finding data that can support better forecasting, (3) avoid uncertainty by cutting lead times, increasing flexibility in order to produce to order or move manufacturing closer to demand and (4) hedge against uncertainty with buffer inventory and excess capacity.

Yusuf et al. (2003) claim that there are four pivotal objectives of agile manufacturing as part of an agile supply chain. These objectives are (1) customer enrichment ahead of competitors, (2) achieving mass customization at the cost of mass production, mastering change, (3) mastering change and uncertainty through routinely adaptable structures and (4) leveraging the impact of people across enterprises through information technology. This list clearly shows that enhanced responsiveness is a major capability of an agile supply chain.

In congruence to our research and experience we summarize that in order to achieve the responsiveness required for innovative products, an agile supply chain should contain the following key characteristics:

1. Flexibility
2. Market sensitivity
3. A virtual network
4. Postponement
5. Selected lean supply chain principles

Flexibility is a key characteristic of an agile supply chain. Flexibility in manufacturing is the ability to respond quickly to the variations of manufacturing requirements in product volume, product variety and of the supply chain. The variability in volume is demonstrated by product launching, seasonal demand, substitution and promotional activities. The changes in variety relate to increased number of SKUs in new products, distributors' own brands (DOB), etc. The variations in the supply chain result from variability of lead times of both suppliers and customers, increased service level, change in order size, etc. There are instances of failures during the 1980s where companies invested in sophisticated flexible manufacturing systems (FMS) in pursuit of flexibility. At the other end of the scale all the attentions were given to organizational flexibility (e.g. cultural and skills integration between craftsmen and operators), producing limited success. Recognizing a closer link between agile processes there is a huge interest in the service sector, also how to optimize the benefits of agile processes for a faster response to customer demand. In order to improve flexibility in a supply chain, it is crucial to reduce complexity in product specifications to maximize mass customization, reduce complexity in processes by standardizing them and enhance organization flexibility by multi-skilling and seamless working practices.

Market sensitivity means that the supply chain is capable of responding to real demand. This requires demand planning not to be driven by periodically adjusted annual forecast, but by actual customer requirements. The scheduling of operations will be reverse scheduling based on customer orders rather than forward scheduling based on forecast. In addition to actual customer order, the use of information technology and efficient consumer response (ECR) and customer relationship management (CRM)systems should be utilized to capture data directly from point of sales and consumer buying habits. The growth in 'loyalty cards' and 'store cards' is also another source of consumer data to enhance the management of market sensitivity.

The use of Internet and information technology have enabled the real-time sharing of data between customers, buyers, suppliers, planners, manufacturers and distributors in a virtual network. The visibility of demand and collaborative planning forecasting and replenishment (CPFR) systems (see Chapter 12) in a virtual network are important tools to respond to the real needs of customers in a global market. The concept of competitive advantage through world class manufacturing in individual sites has now shifted to network excellence. The supply chain where a group of partners can be linked together in a virtual network and communicate on-line and on time is a vital characteristic of agility.

Postponement is based on the principle that semi-finished products and components are kept in generic form and the final assembly or customization does not take place until the final customer or market requirements are known. The principle of postponement is an essential characteristic of an agile supply chain. The rapid response tailored the customer needs is also helped by the buffer capacity of key workstations. The point in the supply chain where the semi-finished products are stocked is also known as 'de-coupling' point. This point should be as close to the market place as possible in the downstream of the supply chain. In addition to responding quickly to specific customer demand, the concept of postponement offers some operational, economic and marketing advantages. As the inventory is kept at a generic level there are fewer SKUs and this makes easier forecasting and less inventory in total. As the inventory is kept at an earlier, stage stock value is also likely to be less than the value of finished product inventory. A higher level of variety can be offered at a lower cost and marketing can promote apparent exclusivity to customers by 'mass customization'.

An agile supply chain also shares some lean supply chain principles or characteristics. The enhanced responsiveness of an agile supply chain is in addition to the high level of efficiency, quality assurance and smooth operation flow which are the key characteristics of a lean supply chain. An agile supply chain also focuses on the elimination of waste or mudas as in a lean process but with a different strategy for buffer capacity and inventory required for postponement. However, a pure lean strategy can be applied up to the de-coupling point and then an agile strategy can be applied beyond that point. It should be possible to achieve volume-oriented economies of scale up to the de-coupling point. This is similar to a service operation (e.g. a bank) where the repetitive activities are isolated or de-coupled and carried out in the back office with lean thinking while responsive customer service is provided at front end.

The strategy of a lean and agile supply chain

The above analysis and our experience strengthen the suitability of a pure agile supply chain for innovative products with unpredictable demand pattern with high profit margin and high variety requiring many changes and shorter lead time. A pure lean supply chain, on the other hand is suitable for high volume functional products with a lower margin and variety requiring a few changes. A lean supply chain may also compromise a longer lead time for a lower cost.

A survey by Yusuf et al. (2003), which was carried out by questionnaire to 600 manufacturing companies, showed that only a few companies adopted agile supply chain practices, but many companies embraced long-term collaboration with suppliers and customers, which was conceptualized as lean supply chain practices.

Christopher (2000) comments, 'There will be occasions when a pure agile or a lean might be appropriate for a supply chain. However, there will often be situations where a combination of the two may be appropriate, that is a hybrid strategy'.

Naylor et al. (1997) agree that both agile and lean can be combined in the same supply chain calls it 'Leagile'.

In the business world it is more likely that companies have a mixed portfolio of products and services. It is also likely many high volume manufacturers or service providers experience short-term or seasonal demand of novelty products (e.g. chocolate eggs at Easter and T-shirts for the Olympics). There will be some high volume products where demand is stable and more predictable and there will be products with sporadic demands seeking agile response. Therefore, it is not important to follow either lean or agile supply chain strategy. However, it is important to recognize that a supply chain can be lean for part of the time, agile for part of the time and both lean and agile (hybrid) for part of the time.

Case example: A lean and agile supply chain

Zara is a successful apparel company in Spain supplying fashionable clothing to an international target market of young customers between the age of 18 and 35. The market positioning of the company places it in competition with some of the leading operations in the business, including the Italian company Beneton, the US based Gap, and the UK based FCUK and Monsoon.

The process of supply planning starts with a cross-functional team comprising fashion, commercial and retail specialists working in Zara's head office in La Curuna, Spain. The design reflects the international fashion trends of target customers with inspiration gained through visits to relevant fashion shows, stores, university campuses, cafes, clubs and events appropriate for the life style of young aspiring customers. The team's understanding fashion trend and demand forecast is further guided by regular inflow of sales data from company's stores around the world.

Raw materials are procured from three buying offices in the UK, China and the Netherlands and most of the materials are supplied from India, China, Mauritius, Turkey, Morocco and also from New Zealand, Australia, Italy and Germany. Approximately 40 per cent of broadest but least transient garments are purchased as finished products from the low cost centres of the Far East. The remaining 60 per cent are produced by quick response in Zara's-automated factories in Spain and a network of small contractors. Materials or fabric are also held in semi-finished form (e.g. un-dyed and un-printed),

Zara's manufacturing systems are modelled upon ideas developed in conjunction with Toyota. The operations with a higher economy of scale (e.g. cutting, dying, labelling and packaging) are conducted in-house to enhance cost efficiency. Other manufacturing activities including the labour intensive finishing operations are accomplished by a network of 300 specialist subcontractors. These subcontractors work exclusively for Zara's parent company, Inditex SA. They receive necessary training and technological, financial and logistical support as if they are subsidiaries of Zara. The system is flexible to adjust total capacity depending on the fluctuation of demand and production is kept at level below expected sales to keep the stock moving.

Zara's rapid and sustainable growth in a competitive market is attributed to its ability to establish an agile supply chain which also incorporates many lean characteristics. There is a success story of a combined lean and agile supply chain strategy.

Adapted from Christopher (2000)

Summary

Changing customer and technological requirements, volatile markets and global sourcing have created fresh challenges to supply chain management and the traditional forecast driven longer and slower logistic pipelines are becoming non-competitive and therefore unsustainable. In this chapter, we have discussed how to respond to this challenge by a lean and agile supply chain. We have developed the key characteristics of a lean supply chain as elimination of waste, smooth operation flow, high level of efficiency and quality assurance. We have differentiated the characteristics of an agile supply chain as flexibility, market sensitivity, a virtual network, postponement and selected lean supply chain principles. We have also given guidelines to apply appropriate strategies of lean and agile supply chain. The supply chain objectives and characteristics of a lean and an agile supply chain are summarized in Figure 13.5.

	Lean	Agile
Objectives	• Low cost • High utilization • Minimum stock	• Fast response • Buffer capacity • Deployed stock
Process characteristics	• Elimination of waste • Smooth operation flow • High level of efficiency • Quality assurance	• Flexibility • Market sensitivity • A virtual network • Postponement • Selected lean supply chain principles
Product characteristics	• Functional products • Low variety • Low margin	• Innovative products • High variety • High margin

Figure 13.5 Lean and agile characteristics.

14

Retail supply chain

Introduction

A columnist in the *Times of India*, 6 September 2006 asked readers to picture a busy evening in a small town supermarket in India in 2010. 'Jagannath Dash the manager, watches a large-screen display with satisfaction. He sees from the display that it is time to open more checkout lines and that there is a shortage of shopping carts in circulation. A red light on the screen highlights that it is time to restock the oatmeal rack'. To readers in Europe and North America, or even Australia and New Zealand, the above description would seem to be reflecting what we imagine is already common practice. We would believe, or are led to believe in text books, journal articles and magazines, that computer systems exist and are used that link sales, to stock records, and trigger orders based on preset re-order levels. Such systems are also meant to calculate stock turn and profit margin by line item, and can indicate the customer profile for a particular store. For example, the products being purchased in a particular store could suggest that most of the customers in that market area have young families, one pet animal, buy lower priced wine and will favour on special items. When combined with a loyalty card, where customers gain points for each purchase with a reward once a certain amount has been spent, the computer system could know more about individual households purchasing habits than will the customer themselves know. How many of us know, how much bread and milk we buy a week, or how much we spend on fruit a week?

The theoretical 'ideal' model

For the following described model bar coding and bar code readers are essential in the retail supply chain. In the not too distant future bar coding will be replaced by RFID (radio frequency identification tags). The major difference is that RFID readers can recognize and record transactions without the goods having to be removed from the shopping trolley. Operationally, the process and the benefits are essentially the same.

Point of receipt of goods

When goods are received bar code scanning enables:

Receipt of goods tallied and stock balances updated.
Received goods married to an order number, and the balance of outstanding orders updated and highlighted. Highlighting of shortfall in delivery enables outstanding orders to be followed up.
Amount owing to suppliers – accounts payable – updated.

Point of sale

When sold, bar coding at point of sale (POS) adds up the cost of all the items the customer has picked and does not rely on the arithmetic ability of the check out clerk. The customer generally will present a plastic bank debit or credit card, and sometimes a loyalty card. Irrespective, whether a debit or a credit card, and/or loyalty card from the retailers point of view the result is the same. Eftpos (exchange of funds at point of sale) transfers money from the customers bank and directly into the retailers bank account (less a bank fee) at the time of the sale. No money needs to physically change hands. The check out clerk does not have to possess arithmetic skills and is absolved from having to add up, calculate change, or for being blamed from entering wrong prices. Once the bar code is read into the system the computer does it all.

The bar code action at the POS reduces the potential for human error between the customer and the check out clerk, but even more importantly updates stock records.

Stock keeping records

The POS bar code action automatically:

Adjusts (reduces) the stock balance.
Triggers a re-order on the supplier once a re-order level is reached.
Updates the general ledger for sales and margins.
Calculates daily, weekly, monthly and year to date actual results of sales and revenue and compares to budget.
Upgrades the sales and revenue forecasts.
Produces exception reports for management on slow moving/high moving items.
Calculates stock turn for each line item.
Calculates the margin (profit) per line item.
Updates customer profile details for marketing.
Updates the bank account balance.

Re-order system

The re-order system will require a calculation taking into account stock turn, lead times, and a reserve level to determine a re-order level. It is important in the grocery industry not to hold too much stock not only because of the financial cost of holding stock and limited shelf space, but also the perishability of food items (used by dates). It is also important not to run out of stock. The calculation of a re-order point is important. Bar coding updates information of average lead times, average demand and adjusts for seasonal ups and downs.

Flow of information

A POS system that is integrated with suppliers will enable information to be transmitted direct to the suppliers and further up the supply chain. Apart from the saving in clerical work of repetitive entering, and checking of data and correcting errors the electronic exchange of data as described above enables fast and accurate sharing of information. If organizations can have faith in the system and trust each other, major suppliers (factories and distributors) will be responsible for replenishment of their products based on the information received direct, electronically, from the retail POS. The responsibility of the smooth flow of goods is transferred to the supplier. In effect the supplier can manage the sales and marketing of their products in the retail stores. The major benefits of the direct sharing of information is that key suppliers can react quicker, delivery is quicker, inventory of materials are reduced, and product is fresher.

Cross docking model

With the cross docking process, pioneered by Wal-Mart, orders are transmitted direct to the factory distribution centre or to the distributor (e.g. for imported goods). The distributor (factory or distribution centre) aggregates the demand from all the retail stores and goods will be shipped in bulk to a regional cross docking facility. At the cross docking facility picking slips for each retail store will have been received made up of the various items required per store. Once the trucks arrive from the distributors they are unloaded into the cross docking warehouse. Within no more than 48 hours the goods received from the various distribu tor will have been sorted to match the picking slips, packed and loaded onto trucks at the other side of the cross docking facility for delivery to retail stores in the region.

Figure 14.1 depicts POS integrated system and shows cross docking.

Reality

The above describes what could happen.

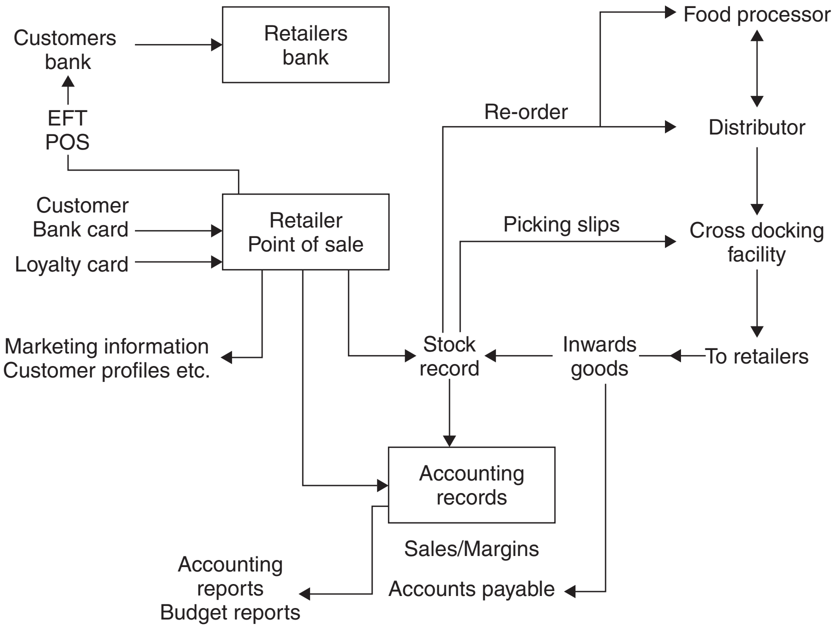

Figure 14.1 Integrated POS system.

The reality is that although the technology has been available for years not all supermarkets or other fast-moving consumer good retailers actually make use of the technology to the extent portrayed above and manual entry of data and repetitive entries at each level of the supply chain are made.

Typically shelves are manually checked, orders are raised by hand and are sent, generally by e-mail, to the regional warehouses rather than direct to the distributors. The regional warehouses manually load orders received from retailers into a computer system. The computer system aggregates orders which are e-mailed to the distributors. As stock outs at retail are unacceptable, to avoid late deliveries regional warehouses find it prudent, indeed necessary, to carry stock in anticipation of orders, and to order ahead of actual demand in anticipation based on past seasonal demand, and late delivery from suppliers further up the supply chain.

Once an order is received from the regional warehouse the distributors in turn manually load the aggregated demands into their computer systems and place orders further up the supply chain, and so on.

Back at the regional warehouse when inwards goods are received they will be entered into the computer to update the regional warehouse stock records. Most systems will not allow goods to be despatched until they have been receipted into the computer system. Picking slips are generated by the regional warehouse computer. In a parody of the cross docking process goods are received in one side of the warehouse and despatched from the opposite side. When received, after being entered into the computer, goods are stored in racks. When the picking slips for each retail store are printed they show the packer, the order in which to collect and accumulate the various items required by each retail store. The computer will calculate and show the shortest route around the warehouse to pick the required bundle of goods. By using a bar coding wand the packer will record what has been packed and the regional warehouse stock records will be updated. Goods are loaded onto pallets for delivery to retailers at the other side of the warehouse. As each delivery truck will be delivering to several stores the delivery route will be planned to reduce the distance travelled. The order in which pallets are loaded onto the delivery trucks will take into account the order in which they will be delivered.

The above process, with data being re-keyed (with added opportunities for human error) into respective computer systems is shown in Figure 14.2. It is

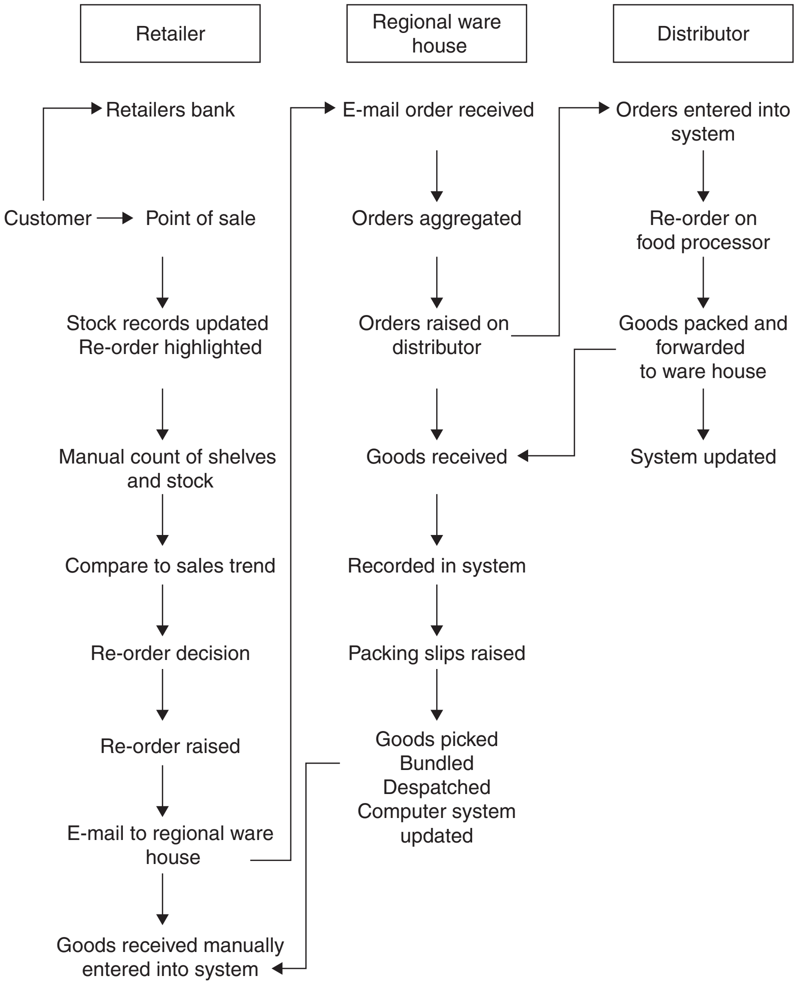

Figure 14.2 Non-value adding activities.
(*Note*: Three Separate Computer Systems.)

not hard to find non-value adding activities in this approach. Compare this to the true cross docking process shown in Figure 14.3. The more entries are required the more chance there is of errors and delays.

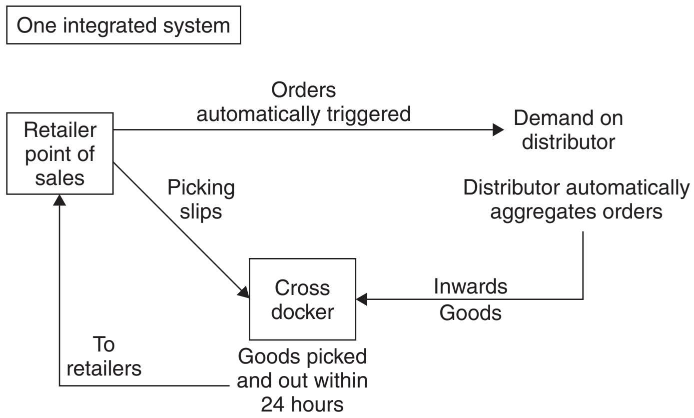

Figure 14.3 Cross docking system.

The automated integrated system shown in Figure 14.3 requires trust in the system and trust in each member of the supply chain. Having trust in the system is one thing, being practical is another. An often quoted example of where an organization reacted to computer generated information is Volvo and their green cars. In the mid-90s Swedish car maker Volvo found itself with too many green cars in the middle of the year. The marketing department was tasked with moving the green cars. They did a great job but the problem was that the supply chain planning team had not been notified of the promotion on the green cars and it appeared that there was an increasing demand for green cars! As sales increased, production stepped up to match demand. The end result was Volvo was left with a huge inventory of green cars at the end of the year.

Supply chain speed

The amount of information available to retailers re-point of sale, buying patterns, customers tastes, seasonal fluctuations, and lead times is enormous. But, we have all experienced going to a store to find that it does not have the item we want. And what retailer, especially in the fashion industry, has not been caught with huge stocks which have to be cleared at below cost at the end of the season? It would seem obvious that retailers at the beginning of a 'season' once early sales figures are known would update their sales forecasts and order accordingly and thus reduce the likelihood of selling out of 'hot' products and/or being caught with large stocks of unpopular items at the end of the season. However, in many cases, especially in the apparel industry, retailers cannot change their pre-season sales orders as the lead time is such that orders have to be 'fixed' before the season begins. Fisher et al. (2000) from their research give the example of a large apparel retailer in the USA having to order 11 months in advance for products with product life cycles of only 3 months. The retailer in question did do product testing but 'the problem is we already own the product; the test merely reveals that it will be a dog once it gets to the stores'.

One manufacturer has found a way to overcome the lead-time problems so as to be able to quickly respond to fashion. Benetton, an Italian apparel manufacturer makes sweaters in bulk, but delays the dyeing process until after initial sales figures are received from the retailers. In other words, colour choices are made after the manufacture. This approach has increased the cost of production by 10 per cent but has resulted in improved forecasts, less surplus stock and due to quick response to customer demand higher sales which has more than compensated for the increase in production cost. Major retailers are responding to challenges of lean and agile supply chain (see Chapter 13) as the following case example of Tesco illustrates.

Case example: Lean retail chain – Toyota to Tesco

Tesco is the largest retail chain in the UK with a global network. In 2006, Tesco turnover was nearly £47 billion with a trading profit exceeding £2.5 billion. At the heart of Tesco's recent success lies an obsession with lean retail supply chain based on principles learned from Toyota.

Its product range increased, between 1983 and 1996, from 5000 to 40,000 stock keeping units (SKUs) but at the same time lead time to stores came down from 7–14 days to 2 days, stock cover from 4.4 weeks to 2.4 weeks. This improvement was achieved by traditional initiatives of supply chain management such as centralized distribution, centralized ordering, POS scanning and Electronic Data Interchange (EDI) with its main suppliers.

Traditional supply chain worked according to the 'motto', better centralized and distant. Back in 1996, a typical product was handled 170 times and spent most of 20 to 60 days sitting in one of the seven different stockholding points. While average availability of 98.5 per cent was good at that time, this translated into, before selecting the substitutes, 55 per cent chance of finding 40 items on the shelf.

Tesco learned from Toyota's lean production principles and, after 1996, began to understand what it would take to create value streams which really flow towards the customer. In the stores work began on ways to reduce handling and streamline the flow of goods to the shelf. Tesco achieved 99.8 per cent availability for its customer and stock cover of 3.5 days in its total supply chain, much more like Toyota. More recently, work also began in RDCs (Re-distribution Centres) to streamline incoming receiving and inspection and to prepare flow of fast moving products straight through to despatch.

The key next step for Tesco and its major suppliers was to jointly analyse changes in demand pattern using Collaborative Planning Forecasting and Replenishment (CPFR) to adjust production volumes to agreed forecast and also to decided off-line stock and stocking points. Many manufacturers had already been using lean manufacturing techniques such as total productive maintenance (TPM). Products would be made to order and picked up by milk round where they would flow through the RDC and out to the store within 2 to 5 days being touched only 70 times and stopping in only two stocking points.

With the introduction of the Clubcard scheme on-line shopping by customers Tesco has been building up a customer relationships management (CRM) system and plans to use loyalty card and home shopping data to customize the range of products displayed in each store to the buying profiles of that store's customers. Given the growing diversity in types of customer and many alternative routes to market it is unlikely to have just one solution. However the key to doing so will be a relentless focus on a customer-driven supply chain.

Adapted from Jones and Clarke (2002)

Accuracy of information

The underlying assumption with the bar coded 'ideal' model is that information is accurate. In the USA in the grocery industry the annual stock shrink is $92 billion. Stock or inventory shrink is a term used for the discrepancy between what the records show as being the balance and what is actually physically on hand. This is a loss that goes straight to the bottom line! The problems are many. In 2005, shoplifting accounted for $5 billion and employee theft for a staggering $46 billion, Nishi (2006). The other $41 billion loss was due to human error.

Human error is most likely to occur when entries are hand keyed rather than bar code read. Other examples are when an item is returned because it is the wrong size and it is replaced by the sales person without scanning the return and the replacement product although prices could be different. Irrespective of price the stock records for both 'small' and 'large' size will be wrong. In the grocery trade the check out clerk will often scan in one item several times rather than scanning six similar items. For example, out of six packs of different flavoured yoghurt, only one will be scanned perhaps six times at the same price. Fisher et al (2000, p. 121) report that one supermarket chain consistently record sales of medium ripe tomatoes to be 25 per cent higher than the actual amount of medium ripe tomatoes delivered to the stores, 'if it's red and soft it's a medium tomato at check out' although the actual tomato might be a higher priced vine ripened. Other problems are the recording of inwards goods, for example the amount of items per container could be entered as 20 in the re-order system when the delivery pack only contains 12. Unreported breakages, damaged goods and goods past the use by date account for much of the balance of shrinkage.

Supply chain forces

'The dynamic nature of the supply chain is evident in both the changing nature of the structure of the supply chain and is also evident in the day-to-day activities of members at each level. In a typical supply chain, each member creates disturbances, either independently or in response to actions taken elsewhere within the supply chain. These disturbances frequently create a chain reaction' (Wright and Race, 2004, p. 211). This latter phenomenon is often demonstrated in a management simulation known as 'the Beer Game'. The 'Beer Game' has its origins in a role-playing exercise for a simple production and distribution system developed by MIT in the 1960s. Variation of the game have been used in business schools around the world for over 40 years, in particular in MBA programs. Simchi-Levi et al. (2003), as have others, developed a computer based simulation games to enable students to explore issues associated with supply chain dynamics. The original beer game consists of a basic supply chain of a single retailer, drawing on a single wholesaler, who in turn draws on a single distributor, who in turn is supplied from a single brewery with unlimited raw materials that supplies the distributor. There is no limit to the amount of stock each member of the supply chain can keep. The constraints are that there is a lead time for delivery and a fixed order delay time for each re-order and delivery step in the chain.

In the original game each of the players manages one of the supply chain companies. Each 'week' the lecturer in the role of the end user customer gives the 'retailers' a demand order, and the retailer fills that order if possible and calculates an order for the wholesaler. If the order cannot be totally fulfilled a 'backorder' is recorded. Each of the other two members of the supply chain, wholesaler and distributor, also observe the demand, satisfy the demand if possible and/or records a backorder and places an order, or in the case of the factory schedules production. The person running the game (the lecturer) after a few 'weeks' feeds in a change to demand and the whole supply chain has to react to this change. The lead time and delivery time constraints cause a delay in the system. As a result the players tend to over order especially when backorders exist. Due to these disturbances the supply chain as a whole appears to have dramatic up and down demand changes. These changes are magnified at each successive stage up the supply chain. Thus inventory and backorder levels vary markedly from week to week. At the end of the simulation players blame the other players for causing the situation.

The game is also described in great detail in Senge (1990). As Wright and Race (2004) say there is no real beer in the beer game and it does not promote drinking though it does lead to some interesting behaviour amongst participants.

What is interesting about the beer game is that it has been played so many times yet the patterns of behaviour generated in the game are remarkably similar. The beer game introduces the players to the phenomenon known as the 'bullwhip effect'. In practice, this phenomenon is observed in all forms of the supply chain but especially in retail supply chains.

The bullwhip effect

As Melnyk and Swink (2002) describe, the bullwhip effect occurs when a small disturbance generated by a customer produce successively larger disturbances at each upstream stage in the supply chain. Bullwhip effects are of great concern because they incite excessive expediting (moving certain orders ahead of others), increased levels of inventory, uneven levels of capacity utilization (where plants go from being idle to working overtime) and ultimately, increased holding costs for stocks of goods.

Simchi-Levi et al. (2003) give the following illustrative example. Proctor and Gamble in examining the demand for Pampers disposable nappies noticed an interesting phenomenon. As expected, retail sales of the product were fairly uniform; there is no particular day or month in which demand is significantly higher or lower than any other. However it was noticed that distributors' orders placed to the factory fluctuated much more than retail sales. In addition P&G's orders to its suppliers fluctuated even more.

Why does this effect occur? In the absence of information, suppliers are likely to overreact to changes in order sizes, whether upward or downward. The amplification of variations through the stages of the supply chain results in the bullwhip effect.

Wright and Race (2004) explain that the main factors contributing to the increase in variability in the supply chain are as follows:

1. *Demand forecasting*: Traditional inventory management techniques, practiced independently at each level in the supply chain lead to the bullwhip effect. Forecasting is typically used to estimate average demand and demand variability. These are used to determine the re-order point and safety stock levels. The more variable the demand the higher the safety stock level and hence this can lead to changing the order quantifying increasing variability.
2. *Lead time*: Increase in variability is magnified with increases in lead time. With longer lead times a small change in the estimate of demand variability implies a significant change in safety stock and thus re-order quantities thus leading to an increase in variability.
3. *Batch ordering*: If the retailer uses batch ordering the wholesaler will observe a large order followed by several periods on no orders, followed by another large order. Thus the wholesaler sees a distorted and highly variable pattern of orders. Also requirements to ship full truck loads can lead to the same order pattern. Similarly end of season sales quotas or incentives can also result in unusually large orders being placed on a periodic basis.

4. *Price fluctuation*: If prices fluctuate, retailers often attempt to stock up when prices are lower. This is accentuated by the prevailing practice in many industries of offering promotions and discounts at certain times of the year.
5. *Inflated orders*: During shortages or periods of allocations retailers will inflate their orders to ensure that they will receive supply proportional to the amount ordered. When the period of shortage is over they will revert back to standard orders further distorting demand estimates.

These factors all contribute to increase the variability of orders placed within the supply chain. One of the first steps that can be taken to reduce the bullwhip effect is to ensure all stages in the supply chain have access to the customer demand information. By centralizing the customer demand information and sharing it with all stages the bullwhip effect can be reduced but it will not be eliminated.

Simchi-Levi et al. (2003) suggest the following methods for coping with the bullwhip effect:

1. Reducing uncertainty by centralizing demand information, that is, by providing each stage of the supply chain with complete information on actual customer demand.
2. *Reducing variability*: The bullwhip effect can be diminished by reducing the variability inherent in the customer demand process. This can be achieved through using an 'everyday low pricing' strategy, that is offering a product at a single consistent price. By eliminating price promotions, a retailer can eliminate many of the dramatic shifts in demand that accompany such promotions.
3. *Lead-time reduction*: Lead-time reduction reduces the amount of 'safety stock' estimated to be carried.
4. *Strategic partnerships*: Engaging in any of a number of strategic partnership initiatives can eliminate the bullwhip effect. These initiatives are outlined below.

Information and integration

Wright and Race (2004) observe that information enables the supply chain to be integrated. Within any supply chain there are many systems. Managing any one of these systems is complex and involves a series of trade-offs with the need to balance the two objectives of customer satisfaction and resource utilization. To manage the whole supply chain requires even more complex trade-offs. The complete supply chain needs to be considered as a whole and decisions concerning the whole need to be made. In many supply chains there is no common owner to co-ordinate the whole process, each step will be separately owned and controlled and each with an understandable aim to do the best for their operation. Without co-ordination the result is local optimization and each member of the supply chain tries to optimize their own operation without consideration of the impact of its actions on the other members components in the supply chain. What is desirable is global optimization which implies that we identify what is best for the whole system. To do this involves addressing the following two issues:

1. Who will optimize?
2. How will the savings obtained through the co-ordinated strategy be split between the different supply chain facilities?

These issues can be addressed in various ways.

Strategic alliances

In order to achieve an integrated supply chain the various members need to work together. The three most important types of supply chain related strategic alliances are third-party logistics (3PL), retailer–supplier partnerships (RSP) and distributor integration (DI).

Third-party logistics (3PL)

The use of a third party to take over some or all of a company's logistics responsibilities is now common. 3PL is simply the use of an outside company to perform all or part of the firm's materials management and product distribution function. This might include one or all of the activities of transportation, warehousing, package delivery and information systems. 3PL relationships are certainly more complex than traditional logistics supplier relationships. Modern 3PL arrangements involve long-term commitments and often multiple functions or process management. The aim is to allow organizations to focus on their core competencies and to allow specialist organizations to manage non-core activities. However, unless the subcontractors or partners are competent the danger is that control will be lost. Any subcontracting has to be carefully thought through as once an activity has been subcontracted out, and skilled staff (intellectual capital) has gone it is hard to rebuild.

Retailer–supplier partnerships

As customer satisfaction become more important in gaining a competitive edge and as due to large-scale world class competition prices have been driven down and margins have become tighter at retail it makes sense to try and to create co-operative efforts between suppliers and retailers. The objective should be to achieve benefits for all parties and not for one party to try and to dominate at another's expense. The types of RSPs can be viewed on a continuum. At one end is information sharing, in the middle is continuous replenishment enabled by sharing information from POS, and at the other end is a consignment scheme of vendor-managed inventory (VMI).

In a simple quick response strategy, suppliers receive POS data from retailers and use this information to synchronize their production and inventory activities with actual sales at the retailers. In this strategy, the retailer still prepares individual orders, but the POS data is used by the supplier to improve delivery performance and hence reduce supply variability.

In a continuous replenishment strategy, sometimes called rapid replenishment, vendors receive POS data and use this data to prepare shipments at previously agreed upon intervals to maintain specific levels of inventory.

In a vendor-managed inventory system, the supplier decides on the appropriate inventory levels of each product and the appropriate policies to maintain these levels. The goal of many VMI programmes is to eliminate the need for the retailer to oversee specific orders for replenishment. The ultimate is for the supplier to manage the inventory and only receive payment for it once it has been sold by the retailer in essence the retailer is providing an outlet for the supplier!

Distributor integration

Modern information technology has enabled this strategy in which distributors are integrated so that expertise and inventory located at one distributor is available to the others. DI can be used to address both inventory-related and service-related issues. In terms of inventory, DI can be used to create a large pool of inventory across the entire distributor network thus lowering total inventory costs while raising customer service levels. Similarly DI can be used to meet the customers specific needs by directing those requests to the distributor's best suited to address them. The down side is that if you were a retailer stocking high value electronic equipment, why would you want to deplete your stock by supplying a competitor with goods so that they can make sale? Who is making the profit and who has incurred the financial cost of stock holding and carrying the risk?

Who has the power?

In days gone by the power was with the farmers. After the Second World War farmers in the western countries in Europe, in North America and Australia and New Zealand were given government subsidies and grants. Without doubt farmers in the main did use subsidies and grants to restructure and to adopt labour saving machines. But today even the wealthy countries in the European Union can no longer afford to support extravagant subsidies to maintain inefficient farming. During the period that farmer power was waning manufacturing and food processors were though mergers, and takeovers were getting stronger. For example, in the USA four beef processors control over 80 per cent of beef processing. In this system the farmer becomes a contractor, providing labour and capital but never owning the product as it moves through the system. The major management decision for their farms are not made by the farmers. Professor Lang of City University says 'it is a similar story with agrochemicals seven firms account for 90 per cent of worldwide sales'. In the grocery industry, the large supermarket chains dictate to the farmers what to sow, when to sow, what fertilizers and chemicals to use, when to harvest and how to pack, and sets the standards for reject or acceptance of produce. The farmer does the work and takes the risk, but has little choice to accept the terms of the supermarket. The international fast food giant McDonald's operates in a similar fashion. The upside for the consumer is a consistent standard of quality.

Even though the manufacturers have become giants it is now accepted that the power is with the retailers, rather than with the manufacturers. In the grocery industry, and also for other retailers of fast-moving consumer goods large conglomerates such as Wal-Mart (trading as ASDA in the UK) and Tesco's are the big spenders. In the UK, five major supermarket chains account for just on 70 per cent of food sales, and over 50 per cent of food in the UK is sold from 1000 huge super or hyper markets. Cap Gemini Ernst and Young in an extensive market analysis, *The State of the Art Food Report* (2003) conclude that in the near future four or five large retail organizations will operate on a worldwide scale and 10 food manufacturers/processors will operate globally with 20–25 global brands, along with a number of consumer goods companies that will be dominant in particular countries or regions. Add to this consumers have a growing degree of choice and greater ability to make comparisons. As a result their expectations are rising and needs constantly changing. In 1975 items available to consumers (SKUs) in supermarkets totalled 14,000 and by the end of 2006 the number is estimated to be 300,000! In 2006 in the USA 13,000 new items were added to the list, of which it is expected that 11,000 will not survive.

Value in this environment is a moving target. Any organization must be flexible to be able to adapt to these changes. It is very difficult for a single organization to possess all the capabilities required to keep up. The large retailers can control, or as some say black mail the manufacturers and processors. Smaller organizations do not have this clout. They now look for suppliers who can provide the skills and capabilities needed as they require them. Smaller firms form partnerships with appropriate skilled suppliers that last as long as the need exists. As demand changes so to do the partnership arrangements.

Advances in technology

The merging of information and communications technologies has supported the growth in supply chain partnerships. These technologies have enabled extensive connectivity. Today's computer networks, open systems standards and the Internet enable people working in different areas of the supply chain to maintain constant contact. Since information transactions have become so easy, there is less of a need to restrict operations to within traditional organizational boundaries. These new capabilities offer the ability for supply chain partners to share information in real time. This enables the partnering firms to hold lower inventories and incur fewer transactions costs. These lower costs can in turn be passed on to the customer in the form of lower prices and better value. Or alternatively retained as increased profits!

Organizations are increasingly recognizing that great improvements in value can be attained by co-ordinating the efforts of partners along the supply chain.

When firms focus only on their internal operations they are making decisions in isolation and as a result this can lead to the overall performance of the supply chain deteriorating. Firms who work together and share their plans and other information are actually able to improve the overall supply chain performance to their mutual benefit.

The Internet and the supply chain

The power of the Internet in providing ready information and quick exchange of information has enabled major changes in business practice. The direct business model employed by industry giants such as Dell Computer and Amazon.com enables customers to order products over the Internet and thus allows these companies to accept orders direct from end users and in turn allows them to forward product direct to the customer without having to go through a middleman. Apart from parcel delivery third-party distributors and warehouses are no longer needed.

In general the retail industry was slow to respond to competition from virtual stores and to recognize the potential of the Internet. It is however now common for ‘brick and mortar’ retailers to also have a ‘click and mortar’ or Internet shopping facility for customers. Unlike the dot.com companies who for the most part did not carry any stock but acted as an on-line order taker for customers, the large click and mortar companies such as Kmart, Target, TESCO, Wal-Mart, Barnes and Noble, have distribution and warehousing infrastructure in place. One model is for high volume fast moving consumer goods to be stocked in retail stores and on-line orders supplied from there, and slower-moving products to be stocked centrally for on-line ordering and supply. A push strategy is used for the high volume fast-moving goods, and a pull strategy for low volume slow-moving goods.

Likewise, the Internet and the emerging e-business models have produced expectations that many supply chain problems will be resolved merely by using these new technology and business models. Whilst it has promised so much in reality the expectations have not been achieved. In many cases the downfall of some of the highest profile Internet businesses has been attributed to a lack of sound logistics planning.

Nonetheless in developed countries and progressively in the emerging giant economies of India and China most people have a computer at home or have access to a computer at work. In the USA alone by the end of 2007 it is estimate that on-line retail sales, or more accurately ‘e-tail’ sales will exceed $250 billion.

Conclusion

Although business to customer – e-tail – is here to stay, the use of the Internet for business to business integration is the real issue for this chapter. Integration of the supply chain players has been made possible with the use of the Internet and the associated technologies.

The impact of the new technologies on the supply chain provides an interesting development. The Internet and the evolving supply chain strategies has seen a shift in transportation and order fulfilment strategies away from case and bulk shipments to single item and smaller-size shipment and from shipping to a small number of stores to serving highly geographically dispersed customers. This shift has seen the importance of partnerships with parcel industries. It has also increased the importance and complexity of reverse logistics of handling the significant numbers of product returns. One of the big winners in the new developments is the parcel industry. An important advantage for the parcel industry is the existence of an excellent information infrastructure that enables real-time tracking. Those players in this industry who work to modify their own systems in order to integrate it with their customers' supply chains are likely to be successful (Simchi-Levi et al., 2003; Wright and Race, 2004).

As organizations come to understand the power of the Internet, new models of business are sure to evolve. One thing is that certain supply chains of the future will be managed along the lines of the Indian journalist we quoted at the beginning of this chapter. It is obvious that the big players will take the co-ordination role. We are of the opinion that is consumers will benefit. There will be greater selection, quality will be consistent, and grocery items will be fresher. Although prices will not go down savings in costs throughout the supply chain will keep prices at a reasonable level.

The future looks to be exciting and bright.

15

Green supply chain

Introduction

Organizations are facing increasing challenges to balance business performance with environmental issues and these challenges have created a new area of green supply chain management. Green supply chain refers to the way in which organizational innovations and policies in supply chain management may be considered in the context of the sustainable environment. If industry is seen as a complex web of buying, making, selling and delivering, then the opportunities for environmental considerations when brought into play in supply chain management could not only provide sustainable environmental measures but also be beneficial to both organizations and individual consumers. The objectives of green supply chain management are aimed at a win-win strategy. Environmental regulations are also changing the way supply chains are designed and managed. The problem is that the sheer number of regulations, other influences such as changing consumer sentiment, and the complexity of global trade, makes it difficult for companies to decide exactly how they should respond to these pressures.

Not surprisingly, there are instances in recent history where the performance of manufacturing businesses was drastically affected due to negligence in environment and safety standards. A failure in product safety which caused deformed 'thalidomide children' is still haunting the manufacturers. The gas explosion of 1984 in Bhopal, India, which killed over 1000 people, permanently damaged the business of the manufacturers. Food poisoning costs to John Farley and Wests were huge. Environmental pollution by chemical companies in New Jersey resulted in numerous legal battles with consumers and also affected their business performances. On a global scale industrial pollution is the main contributor to the so-called 'greenhouse' effect and global warming.

The greenhouse gases include carbon dioxide, methane, CFCs (chlorofluro-carbons) and nitrous oxide. CFCs are produced only in industrial processes. The combustion of fossil fuels (coal, oil and natural gas) is the major source of manufactured carbon emissions. Greenhouse gases allow incoming radiation from the Sun to pass through the atmosphere of the Earth. The Earth absorbs the radiation and reflects it back. When this outgoing radiation meets particles of a greenhouse gas the radiation is absorbed by the particle, and on a large scale all greenhouse gases around the Earth form a sort of warm blanket causing global warming. Some scientists believe that increased emission of greenhouse gases, particularly carbon dioxide, are causing energy to be trapped, increasing the global temperature.

CFCs are used in aerosols, refrigerator coolants and air conditioners. They are a strong contributor to the greenhouse effect but are relatively easy to regulate because they only result from the manufacture of refrigeration units and aerosols. Methane and carbon dioxide emissions are linked to a much larger economic infrastructures and are more difficult to regulate. In 1997, the Kyoto Treaty was drawn up in Kyoto, Japan, to implement the United Nations Framework Convention for Climate Change. It largely binds industrial nations to reduce the emission of greenhouse gases by an average of 5.2 per cent below their 1992 levels over the next decade. When the USA pulled out in March 2001, the treaty was severely in disarray. A compromise was reached by 180 nations in July 2001 in Rio de Janiro; the US government refused to sign it as it was argued that not only would Kyoto be bad for the US economy but it would be ineffective, because major developing nations like India and China were not covered by its provisions. Australia also refused to agree to the treaty and more recently (2006) Canada has abandoned the specific emission targets set by the Kyoto agreement. It should be noted that India and China are two of the worlds biggest and most rapidly growing polluters. Some environmentalists argue that emissions would have to be cut by 60 per cent and the target of Kyoto is not enough. They claim gases can remain in the atmosphere for a century or more. On the other hand, not every scientist believes that global warming is any thing more than a cyclical phenomenon and that the temperature of the Earth rises and falls over long periods of time irrespective of greenhouse gases.

Whatever the scientific evidence, or lack of evidence, sufficient number of people (as evidenced by 180 countries signing the Kyoto treaty) mean that no organization can in the long-term hope to avoid legislation and regulations designed to honour the spirit of the treaty.

Our personal belief is that environment and safety are not just social or political issues; they are vital ingredients contributing to the performance of an organization. In manufacturing industries, there is much scope for environment and safety. Accidents do occur and likewise there are many opportunities to prevent accidents. Apart from humanitarian reasons it is a truism that accidents cost money. Likewise many businesses and organizations are facing declining reserves of natural resources, increased waste-disposal costs, keener interest in their human rights' records and tighter legislation. These rising environmental pressures and social expectations can be turned to commercial advantage if a strategic approach is taken to develop a 'green' supply chain. The strategic approach of green supply chain involves complex longer-term considerations involving not just industry but environment protection has an important international issue. Industrialized countries, including the US are spending between 0.5 and 1.5 per cent of their gross national product (GNP) on the control of pollution. It is a big subject and any attempt to make a comprehensive analysis of all the issues is beyond the scope of this book. In this chapter, we aim to review some of the critical issues and initiatives of green supply chain under the following headings:

- What is green supply chain?
- Green initiatives by manufacturers and suppliers

- Green initiatives by governments and non-profit organizations
- Green initiatives by retailers
- Green initiatives by consumers

What is green supply chain?

'Green supply chain' according to Walton et al. (1998) refer to buyer companies requiring a certain level of environmental responsibility in core business practices of their suppliers and vendors. Many businesses have internal standards, policies and/or environmental management systems (EMSs) that govern their own environmental performance and efficiency. And it is becoming increasingly common for organizations to advertise their standards in their marketing. But if their suppliers are not aware of, or do not follow these same standards, the buying company is likely to be using products that do not meet their standards, and in some cases could be accused of misleading advertising.

A supply chain can be complex, with environmental issues occurring at the second- and third-tier supplier levels.

Green supply chain concepts manage environmental impacts where they occur, ideally before they occur. As shown in Figure 15.1, green supply chain recognizes the disproportionate environmental impact of supply chain processes in an organization and balances the issues arising from both sides to satisfy the stakeholders. The stakeholders in the green supply chain are not just buyers and suppliers, they also include governments, regulatory bodies, non-profit organizations and above all consumers.

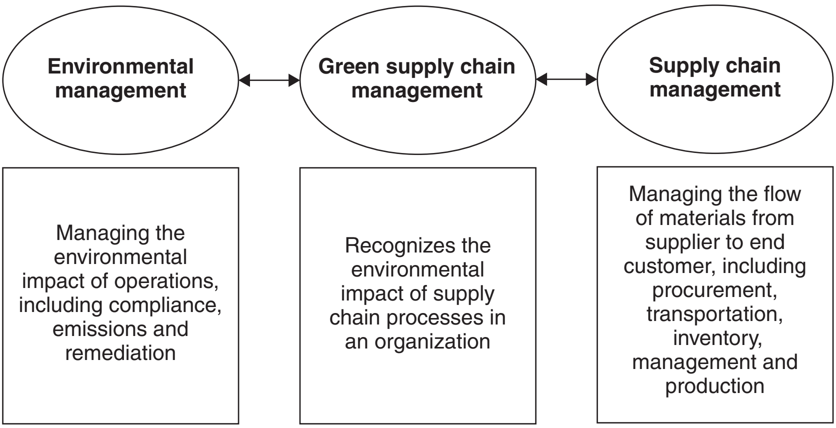

Figure 15.1 Green supply chain concept.

Green initiatives by manufacturers and suppliers

It is reasonable to state that manufacturing industries are major players in environment issues. But when the issues relate to safety, whether for products or workplaces, they apply seriously to both manufacturing and service organizations. Lack of safety in the product or in the workplace will inevitably cost money. Accidents mean lost production time plus time wasting inspections by government officials and perhaps legal costs as well as the cost of correcting the situation. It has to be cheaper to do it right first time!

The Advanced Studies Centre of the Massachusetts Institute of Technology back in 1976 studied the cause and effect of environment factors on the performance of a wide range of companies from different industrial sectors. It found in all cases that those companies which were most advanced in environment protection were also the most profitable. On reflection it is not surprising that an efficient (and profitable) company will be safety conscious and environmentally aware and will be following best practices. It is however surprising that the investments for environment protection by manufacturing companies swing to the political pendulum rather than to business objective. A report by US Environmental Protection Agency (2000) has concluded that 'a number of leading US companies are providing increasing proof of the link between improved environmental performance and financial gains'. For example, the GM Corporation reduced disposal costs by $12 million by establishing a reusable-container programme with suppliers; Commonwealth Edison saved $25 million through more-effective resource management. Re-evaluating a company's supply chain – from purchasing, planning and managing the use of materials to shipping and distributing final products – with an emphasis on environmental performance leads to savings. However, environmental performance is too often forgotten by supply chain managers. What are supply chain managers missing? Many managers are unaware that improved environmental performance means lower waste-disposal and training costs, fewer environmental-permitting fees and, often, reduced materials costs. In efforts to green their supply chain, some customers may expect suppliers to meet standards equivalent to their internal standards. Others may request that their suppliers implement an EMS or become certified to other industry standards. Many environmental standards and models are available, from national ecolabel certifications to international standards. One of the better-known environmental standards is put forth by the International Organization for Standardization (ISO), known as ISO 14001. 'It is becoming more common for companies to include ISO 14001 compliance as a minimum standard in their procurement policies' (Darnall et al., 2006).

Both customers and their supply chains stand to gain by collaborating on environmental and efficiency improvements. Benefits of partnering are:

- The supplier knows the product better than the buyer and can maximize efficiencies and minimize associated wastes.
- Two or more perspectives (or different expertise areas) are better than one when it comes to designing greener products and processes.
- Working together strengthens the customer–supplier relationship.
- Shared savings and mutual benefits make such efforts even more worthwhile.

Basu and Wright (2005) have established that environment protection relates to pollution control in two stages. Conventional controls or ‘first generation pollution’ controls are applied to pollution in air, water and of noise created in the manufacturing process. Such controls are usually regulated by legislation. There is also a ‘second generation pollution’ which relates to the problems caused by the usage of certain products and chemicals over a long period. The most widespread example of such ‘second generation pollution’ is the contamination of land which permeates ground water.

Causes of pollution

Pollution control engineering has essentially evolved from sanitary engineering and thus the solutions are primarily concerned with effects rather than causes, and with control rather than prevention. The overall ongoing economic impact of pollution has been largely neglected and most of the attention of manufacturing companies has gone to the cost impact of pollution control.

The contamination of land is mostly caused by the disposal of solid wastes by manufacturing industries. With the introduction in the UK of the ‘land fill tax’ the disposal of solid wastes by incineration will be more cost effective and environmentally friendly in the future.

The three main gases causing air pollution are carbon dioxide, sulphur dioxide and nitrogen oxides. For many years the consumption of combustion fossil fuels has been releasing carbon dioxide to the atmosphere faster than it can naturally be absorbed by photosynthesis (provided by trees and plants). As the proportion of CO_2 in the air increases, it absorbs heat and as a result the atmosphere warms up. Sulphur dioxide resulting from the combustion of coal and oil or any sulphur burning process is another pollutant of air and one of the substances causing ‘acid rain’. The damage by acid rain to plants and trees is very evident in parts of Europe. Other acidic gases are the oxides of nitrogen resulting from high-temperature combustion processes in power plants.

Lead is a serious pollutant (neurotoxin) affecting nerves and brain. The sources of lead include emission from motor vehicles, lead pipes carrying drinking water, paint and other industrial processes. The Royal Commission on Environmental Pollution recommended in 1983 the benefits of banning the use of lead in petrol. A second pollution bearing metal is cadmium which is used industrially in batteries, metal plating and micro electronics. The discharge of cadmium from local industries in the Severn Estuary in the UK severely damaged the local shellfish industry. A third heavy metal is mercury, causing hazards to life even today. In the 1950s, the discharge of industrial effluents with high levels of mercury in a Japanese bay led to deformity and death for villagers who ate the fish from the bay.

Another harmful mineral is asbestos, causing painful and fatal diseases such as asbestosis and mesothelioma. Many domestic items such as textured ceiling, ovens, electrical heating equipment in the past contained asbestos. After campaigning by environmental pressure groups, asbestos lagging in power stations and electric sub-stations has been gradually eliminated in the UK.

The noise levels in many 'metal bashing' and packaging industries caused low performance and, more seriously, hearing impairment. Today there are established preventive and protective measures of noise control.

Cost of pollution

In addition to the long-term immeasurable damage done to vegetation, birds, animals and human beings by air and water pollution, there are many instances of huge compensation bills paid by polluting industries.

The notorious case of mercury poisoning in Japan referred to above led to damages of over US $50 million (1971 value) being awarded to 700 people who were crippled and to the estates of 200 people who died.

In 1978, as a result of the wreck of the oil tanker Amoco Cadiz, 200,000 tonnes of crude oil was discharged into the English Channel. The French Government presented claims amounting to $2 billion.

In 1992, Cambridge Water Company (UK) were awarded damages of £1 million in compensation for the pollution of land due to tetrachloroethylene by a local leatherworks company.

Benefits of environmental protection

A sound environment protection policy of a company can earn it an extremely marketable environment friendly image leading to higher sales and profitability.

There are also several published examples of 'non-waste technology' where a project of environment control turned out to be a profit earner.

Case example: Dow Chemical

One such example is the Dow Chemical Company's $7.2 million project for the re-use of cooling water which produced over 10 per cent return on investment and considerably reduced the pollution of a neighbouring river.

Case example: 3M Company

The famous 3P programme (Pollution Prevention Pays) of the 3M Company brought about major savings including $2 million from the elimination of hydrocarbon wastes from a reactive costing process. When 3M instigated this programme back in 1974 the approach was to capture and control pollutions and emissions before they could damage the environment. This approach although effective has been changed to a philosophy of prevention rather than containment. The 3P programme now aims to prevent pollution at source by using different materials, changing the process, redesigning the plant and equipment, and through recycling waste.

Case example: Scottish distillery

Another example is a distillery in Scotland. An effluent treatment project for the control of suspended solids and BOD (biological oxygen demand) produced, with the addition of a drying plant, high quality cattle feed.

Case example: Dutch flower industry

About 65 per cent of cut flowers in the world are produced in Netherlands where land is limited. Mass cultivation in a confined area resulted in fertilizers, herbicide and pesticide contamination.

To correct this problem growing was shifted to rock wool and water. Fertilizer in the water is recycled through the system to reduce waste. Water based growth also reduces the risk of installation by weeds and pests, reducing the need for chemical treatments. The new system also greatly reduced variations in growth conditions, greatly improving the predictability of output.

Producers were able to increase output per space and introduce new harvesting methods to reduce costs.

Case example: Texas Instruments

Texas Instruments saves $8 million each year by reducing its transit packaging budget for its semiconductor business through source reduction, recycling and use of reusable packaging systems

Case example: Pepsi-cola

Pepsi-cola saved $44 million in 2004 by switching from corrugated to reusable plastic shipping containers for 1 litre and 20 oz bottles, conserving 98,000 tonnes of corrugated materials.

Environmental strategies

Royston (1979) suggested an eight-point strategy of environment protection for a manufacturing company:

1. Cut down waste by improving efficiency.
2. Sell waste to someone else.
3. ‘Build on’ extra plant to convert waste into raw materials or products which are valuable to the company or to someone else.

4. Work with self-cleansing and dispersing power of the environment so as to permit maximum discharge or effluent.
5. Negotiate emission standards and subsidies with the authorities and the community.
6. Build a treatment facility needed for residual wastes jointly with another enterprise or the local authority.
7. Build the plant using company staff and know how.
8. Sell the acquired know how to others with the same problem.

Green initiatives by governments and non-profit organizations

Environment protection is going in cycles without showing a continuous improvement. In the 1970s, the environment was a political hot potato but as we became accustomed to the issues, and without doubt some issues were overstated (e.g. it was widely said in the 1970s that oil would run out by 2000, and we all remember the nonsense that was the YK2000). But now since the Kyoto Treaty of 1997, influenced by pressure groups such as Friends of the Earth, and well-publicized activities of Greenpeace, environment issues are again at the forefront. The scientific evidence of global warming produced by scientists (e.g. of the Royal Society) has seriously created a sense of urgency in governments, including the State Governments of the USA, and non-profit organizations worldwide.

One such non-profit organization in the UK is the National Centre for Business and Sustainability (NCBS) which is committed to advancing sustainable policy solutions, and has already shown the way forward through a number of ground-breaking studies. The NCBS is working with a range of businesses and organizations to help integrate the principles of sustainable development into policies, programmes and decision-making processes. The Centre does this by taking a practical approach to sustainability, combining the inspiration of the Co-operative Bank's ethical and ecological policies with a number of practical and applied tools that help put sustainability into a working business context. The NCBS Sustainability Management services include:

- Sustainable policy generation
- Sustainability appraisals
- Measuring and monitoring progress
- Sustainability reporting
- Sustainability visioning and training

Political leaders both in government and in opposition are embedding environmental protection and climate change in their political agenda and proposing 'green taxes' to control carbon emission by industries as well consumers.

A recent UK government sponsored *Stern Review* (2006) on 'the economics of the climate change' has concluded:

1. There is still time to avoid the worst impacts of climate change, if we take strong actions now.
2. Climate change could have very serious impacts on growth and development and if no action is taken global average temperature is likely to rise by 2°C by 2035.
3. The costs of stabilizing the climate are significant but manageable (e.g. 1 per cent of global GDP) and delay will be much more costly.
4. Action on climate change is required across all countries and it need not cap the aspirations for growth of rich or poor countries.
5. Climate change demands an international response, based on a shared understanding of long-term goals and agreement on framework of actions.

The UK government has set up a government-funded non-profit organization called Envirowise (www.envirowise.gov.uk). Envirowise delivers a valuable government-funded programme of free, confidential advice to UK businesses. This assistance enables companies to increase profitability and reduce environmental impact.

Many countries and regions are taking action on environment issues. The EU, and non-members of Kyoto such as the US, Australia, China and India have said that they will reduce greenhouse gas emissions. The UN Framework Convention on Climate Change and the Kyoto Protocol provide a basis for international co-operation on the climate change initiatives. Countries facing diverse circumstances will use different approaches to make contribution to tackling climate change and these approaches will have both direct and indirect impact on supply chain management. Key elements of future international frameworks could include emissions trading, technology co-operation, action to reduce deforestation and adaptation of new cleaner technologies in developing countries.

Green initiatives by retailers

Global retail giants Wal-Mart and Carrefour and other supermarkets all over the world are responding to the pressures on packaging waste reduction and other environmental issues of green supply chain.

The media reports in 2006 are loaded with announcements on 'greening the supply chain' from large retail groups. Wal-Mart a US company and the world's largest retailer, unveiled its packaging scorecard to major suppliers such as Proctor & Gamble, Unilever and Nestle to cut packaging. Wal-Mart hopes that the scheme will reduce packaging across its global supply chain by 5 per cent by 2013.

UK supermarket Sainsbury's announced in October 2006 that 500 of its own-brand goods would be in compostable packaging.

ASDA supermarket, a subsidiary of Wal-Mart in the UK, claimed, as an example, that by taking pizzas out of cardboard boxes saved 747 tonnes of cardboard in a year.

'Friends of the Earth', a non-profit organization in the UK, gave a cautious welcome to Tesco's new environment fund of $100 million but said the supermarket giant still had a very long way to go if it was serious about greening its operations. Tesco would need to address a number of key areas if it was serious about reducing its environmental impacts. These include moving away from car-dependent stores, switching from its global supply chain, radically improving energy efficiency in its stores and cleaning up its supply chains.

Even the airlines, the biggest polluters of CO_2 emission, have joined the bandwagon. Richard Branson committed the next 10 years of profits for Virgin – around $3 billion – to fighting global warming.

There has been stronger emphasis to introduce organic and bio products. The following case example of 'Carrefour Bio Coffee' illustrates that by promoting unbranded 500 g/1 kg coffee in bags as 'organic coffee to support fair trading' in 1997 sales increased by 80 per cent in 4 years.

Case example: Carrefour Bio Coffee

Carrefour is a global hypermarket retail chain organization from France with a turnover over €100 billion and only second to Wal-Mart, the largest retail company in the world.

The first shipment of coffee beans were delivered in 10 kg sacks to Vitrolles, France, in 1970. The beans were roasted in store and sold in 500 g and 1 kg bags. In April 1997 Carrefour launched the 'organic' coffee brand under the name 'Carrefour Bio' to promote organic products and support fair trading. In 2001 it was decided to establish a 'green supply chain' for 'Carrefour Bio'.

The organic coffee marketed under the name 'Carrefour Bio' is not indexed on the world coffee market. The purchase price is approximately 30 per cent higher than the average price in Mexico. The supplier is contracted to pay a guaranteed minimum price to producers. Producers can obtain up to 60 per cent of the value of the coffee at current international rates. Three thousand producers from 37 Mexican communities cultivate coffee using organic methods. A local infrastructure has been introduced to transport people between towns and villages (a 2-hour bus ride replacing what was previously a 2-day walk). A health scheme has been introduced providing free medicine and healthcare and a consortium has been set up to buy basic foodstuffs at cost price.

The coffee is cultivated by small farmers working for Uciri cooperative in Mexico using organic method of farming. Such cultivation helps prevent the land becoming impoverished. The cultivation is carried out in accordance with French Organic Society standards without the use of organofluoridated fertilizers or chemical pesticides for tropical forest conditions. An organic fertilizer comprising sun-dried hand picked stoned cherries and animal waste is spread over the plants. This is the only plant treatment used by the farmers.

Cultivation methods are monitored by an organic certification body. An agricultural education centre has also been established catering for organic farming, animal breeding and bio culture.

'Carrefour Bio' coffee project appears to a win-win initiative for green supply chain. For Carrefour sales for the product increased from 29.5 tonnes in 1997 to 54 tonnes in 2001. The fertility of the land has been protected. The average income per family of producers increased from €53 per year in 1985 to €1524 per year in 2000. The local communities benefited from the infrastructure and facilities for transport, healthcare and education. The consumers are happy with an organic product at an affordable price.

Source: Carrefour Belgium (2002)

Green initiatives by consumers

Consumers have both power and responsibility to enhance the activities and effectiveness of the green supply chain. It is the consumer who pays for the end product or service and it is the consumer who ultimately suffers or benefits from the impact on the environment. The green initiatives from consumers could be manifested in three ways:

1. Make your home green
2. Feedback to retailers
3. Reverse supply chain

'Make you home green' is becoming a conscious target of many consumers. This is effected in two paths. First consumers are attempting to minimize 'carbon emission' by making houses and household appliances more energy efficient and also by moving towards eco-friendly transport. Secondly, encouraged by local authorities, consumers are making good efforts in the recycling of household wastes.

A recent survey in the UK (*The Guardian*, 14 November 2006) showed that the wasteful packaging from goods bought in the shops accounted for 33 per cent of an average household waste. According to a minister in the UK Government consumers should remove offending or excessive packaging and leave them at the checkout. The shoppers are further encouraged to report the stores to the trading standards in an attempt to cut the amount of unnecessary plastics sent to landfill sites. Under a new reward system of a supermarket chain in the UK loyalty points are offered in return for not taking away plastic bags. The chain claims that it is giving out 10 million fewer carrier bags a week.

A reverse supply chain is a process of getting goods from the customers back to the manufacturers. It is a relatively new trend in supply chain management that focuses on 'green manufacturing' to target recycling, recovery and remanufacturing systems. In these reverse networks consumers bring products to a retailer or a collection centre. For example, supermarkets in Germany have a bin where customers leave used batteries. Depending on the particular product, it can be refurbished, remanufactured or recycled; making sure the physical flow is efficient. It is estimated that 63 million personal computers were obsolete (worldwide) in 2003 and about 10 million electric waste products are dumped per year in Japan. Mobile phones can be returned to the store where the new one is purchased. From there, the phones are resold and reused in other countries where the technology that is being phased out in developed countries are being introduced. Many other products have the potential for second use, including computers, auto parts, printer cartridges, refillable containers and a host of other possibilities. In remanufacturing, reverse logistics introduces additional challenges to planning for a closed loop supply chain. Plan, source, make and delivery of the products are affected by the reverse flow of used products and materials for subsequent consumption in manufacturing of new products. Reverse logistics play a key role as retail organizations tend to look at their reverse supply chains more closely to enhance customer satisfaction, cost/time efficiencies and supplier performance.

Case example: Xerox copier take-back programme

Xerox Corporation is an American document management company, which manufactures and sells a range of colour and black-and-white printers, multi-function systems, photo copiers, digital production printing presses, and related consulting services and supplies. Xerox is headquartered in Stamford, Connecticut.

In early 1990s, Xerox launched a new initiative to take back used copiers as a source of materials for new machines. Customers like the programme because they no longer worry about machine disposal.

As a result, 70–90 per cent by weight of machines were re-used and 72,000 tonnes were diverted from landfills in 2003. Xerox estimates that 'several millions' were saved per year.

Summary

'The scientific evidence is now overwhelming: climate change is a serious global threat, and it demands an urgent global response', concludes Nicholas Stern (2006).

Note this has been disputed by other scientists but irrespective of what we believe the pressure is on for industry and nations to adopt a green approach to the supply chain. In this chapter, we have attempted to present a balanced view of various initiatives adopted by manufacturers and suppliers, government and non-government organizations (NGOs), retailers and also consumers. Every stakeholder has a role and responsibility in 'greening' the supply chain. We have shown that there are commercial benefits in reducing wastes (e.g. excessive packaging). Large retailers like Wal-Mart, Carrefour and Tesco are probably facing disproportionate demands from environmental pressure groups and regulatory bodies but nonetheless are showing visible efforts to respond to these demands. As Saha and Darnton (2005) ask, 'are companies really green or are they pretending to be?'

16

Supply chain for major projects

Introduction

According to Wikipedia (the on-line free encyclopedia), 'project management is the discipline of organizing and managing resources in such a way that these resources deliver all the work required to complete a project within defined scope, time and cost constraints. A project is a temporary and one-time endeavour undertaken to create a unique product or service. This property of being a temporary and a one-time undertaking contrasts with processes or operations, which are permanent or semi-permanent ongoing functional work to create the same product or service over-and-over again. The management of these two systems is often very different and requires varying technical skills and philosophy, hence requiring the development of project management'. The Project Management Institutes 'Body of Knowledge' (2004) adds that project management is the most efficient way of introducing unique change.

Because of the one-off unique nature of a project and the repetitive nature of operations, the traditional approach of project management has been conciously different from that of operations management. As supply change management is intextricably linked with operations management, the mind-set of project managers usually excludes the principle of supply chain management. The primary objectives of project management (viz. scope, time, cost and risk) is beginning to include quality as another parameter of objectives. Hence, the objectives of project management (with the exception of scope and risk) are identical to those of supply chain management, viz. quality, cost and time. Typically a major project involves several stakeholders working together with controlled resources to deliver a completed project. A major project has many suppliers, contractors and customers; it has procurement and supply, demand planning and scheduling; it often lasts over several years and has longer lead times. Therefore, we believe that the management of major projects will benefit from adopting some customized supply chain management principles as discussed in this chapter.

It is also evident that there is now increasing awareness amongst both practitioners (www. viasysweb.com) and academics (O'Brien, 2001) of applying appropriate supply chain principles in major projects. The most noticable change in the last three decades is the introduction of information and communication technology with faster and comprehensive systems to improve the efficiency of project supply chains from procurement to supplier.

Case example: Airbus A380

The Airbus A380 is a double-deck four-engined airliner manufactured by Airbus SAS. It first flew on 27 April 2005 from Toulouse in France. After well-publicized lengthy delays commercial flights are not likely before 2008.

Airbus has spent 2 years grappling with the design of the A350 and A380, while archrival Boeing has gone ahead with producing its 787 Dreamliner, winning more than 400 orders for the plane which is due to go into commercial service in 2008. Costly delays in production of the A380 super jumbo and surging demand for Boeing's 787 have rocked Airbus and its parent company EADS (European Aeronautic Defense and Space), which is on its third chief executive in a year. The 12-billion-euro A380 super jumbo project is over budget, over 2 years behind schedule. A decision by the US mail group Fed-Ex to cancel its order for 10 Airbus 380 caused massive losses at EADS. A major partner in the project, BAE Systems, also sold its share in the project.

The problems facing EADS in the Airbus 380 project are many and complex. Analysts have highlighted two problems at the forefront and these are related to funding and supply chain management. For historical reasons manufacturing is a transnational process, structured around key manufacturing units in the UK (BAE Systems), Germany (Daimler–Chrysler Aerospace), France (Aerospace-Matra) and Spain (CASA). Each country is responsible for producing a complete section of the aircraft and then transporting by a specially constructed roll-on/roll-off vessel (built by a shipyard in China) to the final assembly line in Toulouse. In addition the project has hundreds of suppliers, contractors and subcontractors (including Rolls-Royce, GE/Pratt & Whitney, Smiths Industries, Rockwell Collins and Northrop Grumman).

There may not be simple solutions to the complex and serious problems of Airbus 380. However, EADS has recognized the link between project management and supply chain management and has implemented project management methods and tools for suppliers to simultaneously manage resources, time, cost and performance to ensure project success. In a structured course, chosen representatives for suppliers learn and practise a straightforward and effective project management methodology that is adaptable to all types of projects.

Source: www.aerospace-technology.com/projects (2006)

In this chapter, we cover the challenges and opportunities of improving the performance of supply chain in major projects under the following headings:

- What is project supply chain?
- Sharing information in projects
- Collaborative forecasting and scheduling in projects
- Procurement in projects
- Community networking in projects
- Operational excellence in projects

What is project supply chain?

Turner (2000) defines projects as 'unique, novel and transient endeavours undertaken to deliver business objectives'. The transient nature of a project creates urgency for the development and delivery of objectives by a certain time. Operations are also often transient with a delivery target or due date. The novelty in a project creates the need for integration with interfaces between different organizational units working on the project. In a traditional supply chain management, as we have established earlier, all departments or functions are required to interface and integrate to satisfy business objectives. The uniqueness in a project creates risk and uncertainty as it is not possible to predict precisely the outcome at successive stages of a project. Projects work with new resources and stakeholders. Even when, for example a bridge of the same design or software of the same functionality is built or implemented the environment and stakeholders will be different. This third characteristic of uniqueness in a project differentiates it from operations management and this is manifested by additional risks in project management.

Dawson (2000) suggests that the management of a project can be viewed in three dimensions. First, a project can be viewed as a number of stages of life cycle. Second, a project can be composed of what require managing the basic objectives throughout the entire life cycle, that is time and cost, scope and configuration risk and quality. The third perspective of a project can be viewed from a different management levels at which specific aspect of the project is managed and controlled. This aspect of the multi-level communication network creates the project supply chain. As shown in a typical project organization in Figure 16.1, a Sponsor authorizes the project, a Project Board controls project authority, scope and objectives, and the Project Director is responsible for the execution and closure of the project. Reporting to the Project Director is a Project Office responsible for design brief, and the review of cost, time, risk and quality. The project team is supported by Consultants who provide designs and recommendations for improvement. The 'building' of the project is supervised by the Site Office reporting to the Project Director. The typical roles of the Site Office are to assist the project director in the appointment of major contractors and supervise their progress. The Contractors then appoint Subcontractors, mobile site and complete building. In addition, there are external suppliers in the procurement of materials and equipment and other stakeholders (e.g. local authority, investors, users and regulatory bodies).

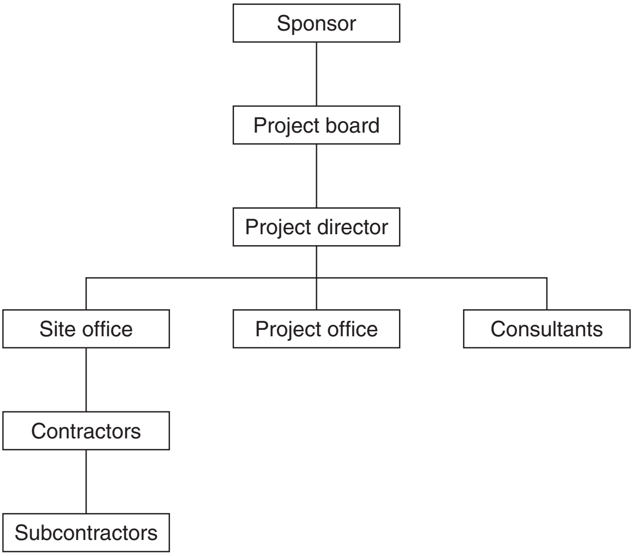

Figure 16.1 A simplified organization structure of a major project.

As indicated earlier, a project supply chain becomes more complex for a major project (such as Airbus 380 or London Olympic 2012) where the project lasts for several years, with many stakeholders, and a multilayer of contractors and subcontractors. Figure 16.2 shows a conceptual model of a project supply chain in a major construction project. Several subcontractors work on such a project. Each contractor is served by several subcontractors and each subcontractor is served by several suppliers. Suppliers in turn can be served by one or more sub-suppliers and so on. We therefore argue that in a major project there a case for deploying a supply chain management discipline (such as risk management) during the total life cycle of the project.

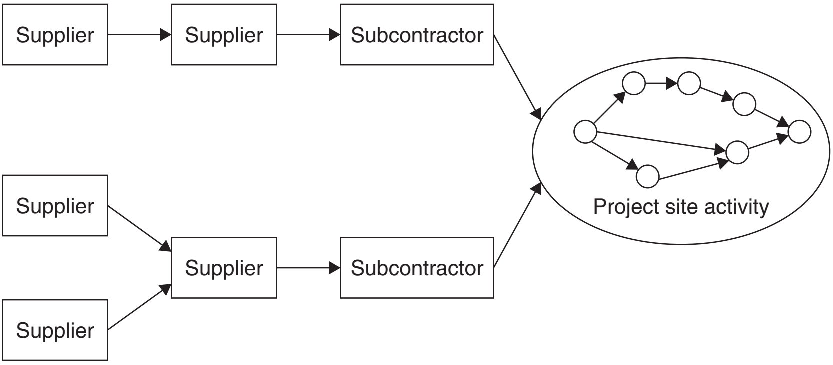

Figure 16.2 A conceptual representation of a project supply chain. (*Note*: Project supply chains are composed of hundreds of firms.)

The management of risk in projects is approached in two ways and they are risk assurance and risk control. The objective of risk assurance is focused on prevention, avoidance or minimization. The tools, techniques and methodologies of project management have been developed and applied to enhance risk assurance. Methodologies, such as BS 6079, ISO 10006, PRINCE2 or PMIBOK which are all aimed at risk assurance (see Pharro, 2000). For example, the principle of project life cycle (see Figure 16.3) breaks a project into manageable stages, such as definition, organization, implementation and closure, to minimize risks. Project management tools such as critical path analysis and earned value management also support risk assurance (see Basu, 2004). Risk control is applied usually with the aid of formal risk registers at all stages of the project life cycle for events occurring in spite of project assurance principles are applied to minimize risks. In Figure 16.3, the four major stages of a project life cycle are underpinned by specialist functions in managing the core activities project management (i.e. risk assurance) such as cost and time, scope and configuration

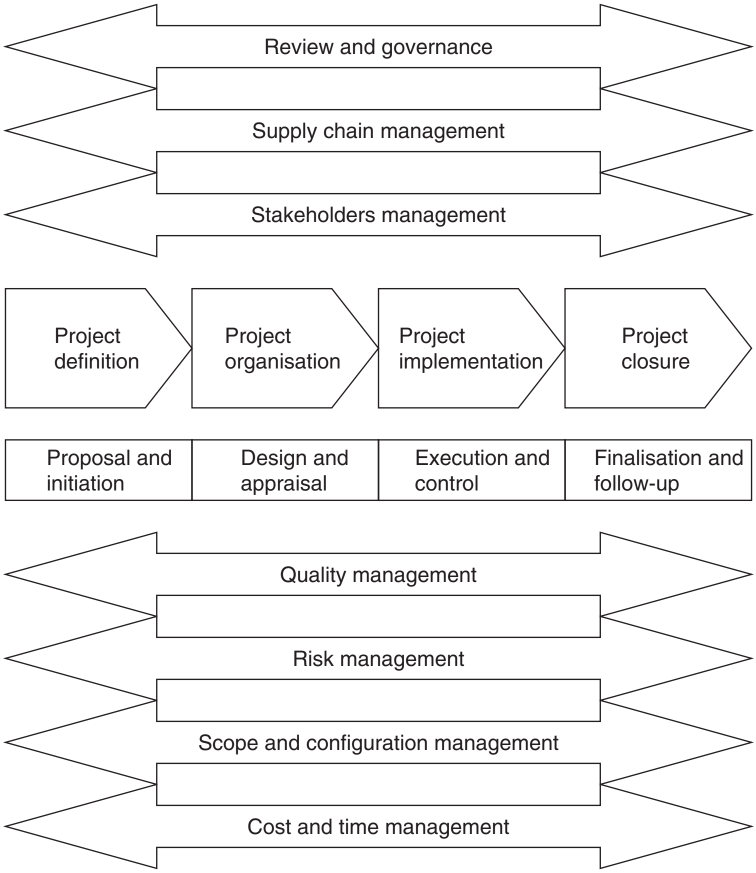

Figure 16.3 Project supply chain and project life cycle.

and quality and risk control. Additional enabling functions such as stakeholder management and governance also span across all stages of the project life cycle. We believe that it is justifiable to recognize the role of supply chain management as a specialist function during the total duration of the project.

The role of this supply chain management function in a major project, as described below, is primarily to import and adapt basic principles of supply chain management from operations management to improve the performance of a project supply chain.

Sharing information in projects

With the increasing use of computers and computerized systems particularly over the last two decades we have become increasingly accustomed to both the problems and opportunities of sharing data on project activities and members of the supply chain. The computer systems in project management are traditionally focused on time and cost control, critical path scheduling and Gantt charts. There are many such project management systems in extensive use and the most popular of these systems are ‘Microsoft Project’ and ‘Primavera’ (see Burke, 2004). In the 1990s, focus was generally on the management of a single project, whereas now within an organization there are likely to be several projects running concurrently. One project will live among many other projects in the enterprise, or may be part of a programme of projects and may utilize resources that are shared among other projects. In order to facilitate governance, it has become essential to be able to manage, monitor and assess the status of all projects in the enterprise, through a set of enterprise project management (EPM) processes, methods and application packages. The corporate network environment is no longer tied to a single vendor, let alone a single platform. A typical EPM system operates from a project management office and communicates with team members working on different projects in the organization; it is yet to expand its collaborative capability to external suppliers and supply chain partners in a major project.

There appears to be significant difficulties in sharing information between members of the supply chain in a major project. Firstly, information exists in many locations and is typically in a raw form not useful for an enterprise system. Secondly, local knowledge is not formalized although there be a large amount of design and procurement information represented on-line. This leads to long meetings between parties and miscommunication. O’Brien (2001) proposes further research on enabling technologies to address these issues and problems of data sharing in the three areas of extracting supply chain data, formalizing local knowledge and sharing product/process visualizations.

Encouraged by the experience of traditional supply chain managers in Collaborative Planning Forecasting and Replenishment (CPFR) between manufacturers, suppliers and retailers, the organizations managing major projects are now seeking solutions from enterprise resource planning (ERP) systems on data sharing amongst supply chain members. ERP was designed at a time when process management was an internal affair. The companies could link their ERP systems through expensive electronic data interchange (EDI) connections.

As we discussed in Chapter 13, web-enabled technologies have now progressed to create e-supply chains. The market for managing the core ERP information (orders, inventory, etc.) of the 'extended supply chain' is only now beginning to emerge in major projects as the following case example illustrates.

Case example: ERP in British Columbia Transmission Corporation major projects

The British Columbia Transmission Corporation (BCTC) is a provincial crown corporation of Canada, incorporated 2 May 2003. BCTC's corporate offices are located in Vancouver. The corporation operates six system control centres all over BC, which are responsible for maintaining the reliability of the 'backbone' of BC's transmission grid which includes 18,000 kilometres of high voltage wires.

Upon receiving approval from the British Columbia Utilities Commission (BCUC), BCTC direct new transmission infrastructure investment projects. The Commission continues to regulate the terms and rates for transmission services.

BCTC selected IBM Business Consulting Services to lead a consortium to implement Oracle Applications version 11.5.9. IBM implemented the project in two waves:

- Wave 1 consisted of the Oracle General Ledger, Fixed Assets, Accounts Receivable, Accounts Payable, Purchasing and iProcurement modules, as well as Oracle Projects, Oracle Discoverer, Oracle Enterprise Asset Management (limited functionality) and integration with BC Hydro, banks and other BCTC systems using Oracle Interconnect.
- Wave 2 consisted of the Oracle iExpenses and Oracle Internal Controls Manager modules, as well as some extensions to Wave 1 functionality.

In the project, IBM led a team that included up to 33 clients and 27 consultants (including Oracle Consulting and Delinea as subcontractors) and also worked with an outside infrastructure application service provider.

The fully integrated solution that IBM implemented is delivering benefits in BCTC's major project management such as better access to information: for example, Oracle Discoverer enables users to build reports on their own without technical support. Furthermore because BCTC's asset data is now segregated from BC Hydro's, BCTC can perform data analysis more easily, thus improving the quality of its decision-making.

Source: IBM Business Management Consultancy (2004)

It is useful to note that SAP AG, largest supplier of ERP systems in the world, is marketing ERP systems specifically designed for major capital projects. SAP for Engineering, Construction & Operations (SAP for EC&O), one of SAP's

23 industry solution portfolios, supports the business processes of project-oriented companies involved in engineering, planning, execution, operation and maintenance of capital intensive projects. Engineering firms and construction businesses are typically involved in costly, high-risk projects and are organized in a decentralized structure which demands a solution allowing high integration and close collaboration both within the enterprise and across global supply chains and partner networks.

Collaborative forecasting and scheduling in projects

As we discussed in Chapter 12, CPFR or just collaborative forecasting is the process of setting up a continual line of communication between you and those customers with the ability to predict the future needs of the products they buy from you. Advances in electronic commerce have facilitated better communications between computer systems that has resulted in the development of electronic CPFR systems. Large retailers like Wal-Mart and Tesco are benefiting from sophisticated CPFR systems by electronic link with the major suppliers' ERP and global supply chain systems.

In the case of project supply chains it may not be necessary to introduce sophisticated e-supply chain or CPFR systems with all members of the supply chain. However, the principles of CPFR and Sales & Operations Planning (S&OP) can be gainfully incorporated in the supply chain of major projects. The supply chain manager in a major project (see Figure 16.3) should take the role of co-ordinating an S&OP style regular and formal meetings between the supply chain members (including major suppliers) of the project. The objectives of this S&OP style meeting is different from a typical project review meeting in so much that here the emphasis is on collaborative forecasting and rough-cut capacity planning. The supply chain related problems in major projects such Airbus 380 or London Olympic 2012 could be contained and resolved by a formal collaborative forecasting process between key suppliers and stakeholders of the project. The benefits are more significant when the supply chain members are electronically linked to share the common data. Even in smaller projects collaborative forecasting can deliver huge benefits as the following case example illustrates.

Case example: Collaborative forecasting in Dower projects

Dower Industries uses a No. 456 gasket in the process of rebuilding a No. A 4000 power unit. On average, Dower rebuilds two power units each month and the building of each power unit is considered a project because the No. A4000 power unit is critical to Dower's operations, its supplier, Ajax Distribution, normally keeps four No. 456 gaskets in stock.

However in a specific month, say September, Dower's engineers decide they need to rebuild eight power units in November … Although the No. 456 gasket is a critical component in the rebuilding process, it is only a small element of the total procedure. Ajax Distribution always has an ample supply of gaskets in stock, so it does not occur to Dower's buyer to notify Ajax of the increased need for the product occurring in 8 weeks.

On November 1, Dower starts rebuilding the power units. After completing four units, they are stopped dead in the water because there are no more gaskets. Dower's management strongly voices its displeasure at the buyer, who in turn unloads on his contact at Ajax. Ajax offers excuses, citing the unusual demand and offers to increase its normal inventory of No. 456 gaskets from four pieces to eight. The result: Ajax has disappointed the customer and brought in additional stock that is probably excess inventory.

This situation could have been avoided if Ajax and Dower implemented a program to exchange need and availability information. Using a CPFR system, Dower would have notified Ajax of the increased need for the gaskets as soon as it made the decision to accelerate maintenance operations. Ajax would have ordered more gaskets for a late October or early November delivery. Following this experience Dower set up an EDI link with Ajax and a simple process of CPFR was established in Dower projects.

Source: www.EffectiveInventory.com (2006)

Procurement in projects

In the preceding two sections we have described the challenges and opportunities created by new information and communication technologies in managing project supply chains. Procurement or purchasing of goods and services from multitude of suppliers has been the traditional home of supply chain management in projects. The roles and responsibilities for the management of procurement in a large project can be seen as a hierarchical sequence of authorization between various levels of the project organization (see Figure 16.1) from sponsor (or a client) to subcontractor. These cascade down from the strategic and commercial drivers acting on the sponsor and progress through various parties in the entire supply chain according to the procurement strategy. There are variations of procurement strategies which are hybrids of the following strategies:

- Client-controlled strategy
- Turnkey strategy
- Joint ventures (JVs) and partnering

The key player is a client-controlled strategy (which is also the traditional procurement strategy in construction industry), sponsor or slient, consultants and contractors. A client initiates and authorizes a project. A consultant undertakes the feasibility and design and a contractor is responsible for implementing the project. The client appoints a Project Board and a Project Director who selects consultants and main contractor. The subcontractors are chosen by the main contractor.

In a turnkey strategy, main contractor has the responsibility for the design, construction and commissioning phases of a project. Usually, client appoints a functional project manager who with his or her project team prepares and monitors a performance specification and scope document. The turnkey contractor's project manager has executive authority and more multidisciplinary responsibilities to co-ordinate the project supply chain. London Olympic 2012 project is broadly following a turnkey strategy and Olympic Delivery Agency is the turnkey contractor.

Primarily because of the financing sources of larger projects Joint Ventures (JVs) or partnering strategies are emerging particularly for public sector projects. Local or regional government policies in some countries (e.g. China) prescribe JV procurement strategies. The public–private partnerships (PPPs) is a hybrid of JV in the UK Government sponsored projects where funding is sourced from both public and private sectors. To operate within these PPP organizations, the project manager is confronted by two types of diverse cultures and yet has to secure effective decisions in project supply chain.

Case example: What is a PPP?

Any collaboration between public bodies, such as local authorities or central government, and private companies tends to be referred to a PPP.

British Prime Minister Tony Blair is keen to expand the range of PPPs because he believes it is the best way to secure the improvements in public services that the labour promised at the last election.

He believes that private companies are often more efficient and better run than bureaucratic public bodies.

In trying to bring the public and private sector together, the government hopes that the management skills and financial acumen of the business community will create better value for money for taxpayers.

Many public sector unions, however, remain sceptical – and are particularly concerned about the extension of the private sector into new areas like schools and hospitals which have traditionally been publicly run.

Source: BBC News (12 January 2003)

The traditional service level agreements (SLAs) where suppliers are penalized for non-conformance of time, cost and specifications are not appropriate for procurement strategy based on partnerships. The traditional procurement thinking should be revisited and there should be a move where a client organization is actively managing the cause of risk or non-conformance and not the effect of the risk. The supply partners are in turn encouraged and incentivized to improve performance and create competitive advantage for their businesses. This type of progressive partnership approach is illustrated by the so-called 'T5 Agreement' of the London Heathrow Terminal 5 Project of British Airport Authority (BAA).

Case example: BAA T5 Agreement

BAA's Terminal 5 (T5) programme at Heathrow Airport is currently (end of 2006) one of Europe's largest construction projects. When complete it will cater for approximately 30 million passengers a year and will provide additional terminal and aircraft packing capacity. The facility is scheduled to be opening to public on 30 March 2008 and represents a £4.2 billion investment to BAA.

To achieve this audacious target in money and programme, BAA had to consider a novel contracting and procurement strategy. Suppliers signing up to BAA agreements are expected to work in integrated teams and display consistent behaviours and values. Before embarking on the T5 programme of works, BAA looked at a number of UK construction major projects to ascertain lessons learnt particularly where they had gone wrong. BAA decided that they had to have an agreement that could deal with an adaptable and dynamic approach dealing with the uncertainties and embracing integrated teams. So BAA wrote their own bespoke agreement or contract. The same conditions of contract apply to all key suppliers irrespective of type or usual position as a subcontract.

The key features of the T5 Agreement include:

- BAA as the client organization holds all the risk all of the time during the total life cycle of the project – on time, in budget and to quality.
- This was underpinned by BAA's unique insurance policy against risk. It is not so much about the cost of the BAA policy but the value it releases. It did not increase the cost of the project as the insurance covers the supply chain on T5.
- As BAA will underpin all financial risks, contractors need not worry that they will be held financially accountable when things go wrong.
- Contractors or suppliers are committed to teamwork in partnership. There is a requirement for a high level of transparency between BAA and their suppliers.
- Contractors work to predetermined fixed profit levels.
- Profit is the key driver of supplier incentives. By taking away the financial risk, BAA is taking away the key commercial constraint and thus suppliers can focus on technical delivery.
- The T5 Agreement is then supported by other documents such as the Commercial Policy which defines an appropriate commercial terms

and conditions and the Delivery Agreement which is the legal deed and conditions of contract.

BAA divided the programme into 18 projects ranging in size from £10 to £200 million. These were then split further into 150 sub-projects and then it was split into *circa* 1000 work packages. The suppliers are engaged as and when on plans of work or where a supplier's capability is required. From the very start BAA requested that suppliers work together in completing the projects, even those that are traditionally rivals or lower tier subcontractors. At a corporate level BAA ensured that all suppliers understood that corporate objectives were aligned to achieve a high quality product within expected cost and enhance reputations. BAA also dealt with challenges in encouraging the entire workforce to understand, appreciate and trust the working relationship both between contractors and BAA. They constantly have to reinforce this message to the workforce.

The T5 project is on course to completion complying with targets for time, budget and quality having generated a team working and partnership culture. The T5 Agreement as a whole looks to become a template in other major programmes. It now represents a serious alternative procurement route for major programmes of work and project supply chains.

Source: BAA Terminal 5 Project (Basu, 2006)

Community networking in projects

A supply chain of a major project deals not only with several contractors and subcontractors, but also with numerous internal and external 'stakeholders'. There is a distinctly more interest in project management today to take stakeholders into consideration. The internal stakeholders are relatively easy to identify because of their closer proximity to the project and can be broadly classified depending on their interest and influence on the perceived outcome of the project (see Figure 16.4). The internal stakeholders with high influence and high interest are usually the core members of the project team. Steering

Figure 16.4 A stakeholder management model.

team members could be chosen from the internal stakeholders with high influence but with less interest. The stakeholders with high interest but less influence are good candidates for task team members.

The external stakeholders are more difficult to identify and engage in a project supply chain. Turner (1995) defines this group as ‘a group of people who are often involved without their prior agreement, sometimes against their will, and who often view the project as being a disbenefit because it somehow distracts from their local environment’. Pryke and Smyth (2006) argue that major projects are inherently ‘social’ and suggest so called community network relationships to deal with both the key players of a project and the external stakeholders. Sometimes projects may not fit into the core operation of an organization or they may be geographically isolated from the centre of operation. As shown in Figure 16.5, a major project resides in larger social or community network boundary and the success of such a project is relationship dependent not only within the project environment, but also in its wider social or community network. There are several relationship models and approaches in literature, for example the IMP approach (Ford et al., 2003) and the Nordic School approach (Gummesson, 2001) and the perceived value approach (Smyth, 2004). Our opinion, based on observation, is that these approaches are primarily academic. They stimulate thinking among project team members but do not provide any specific practical or best practice solutions. Major concerns still remain how to communicate with external stakeholders throughout the project life cycle. Given that a long and costly investment is necessary for building up a relationship, it is recognized that developing relationships with stakeholders at the project initiation stage and maintaining relationships with communication is important.

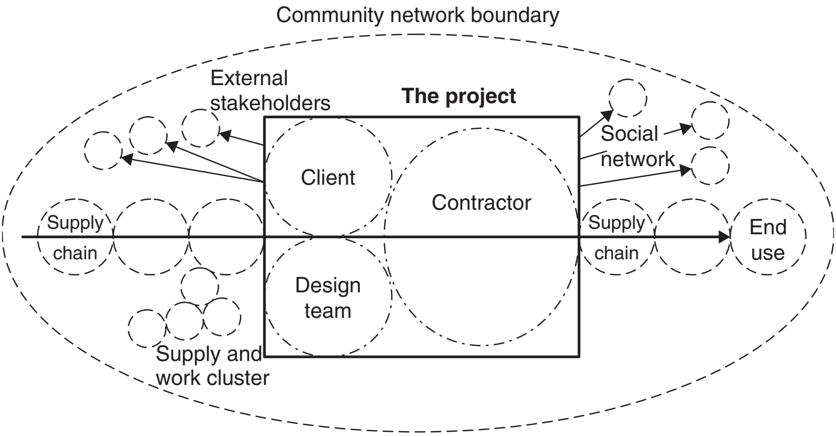

Figure 16.5 Project supply chain in a community network.
Source: Adapted from Pryke and Smyth (2006, p. 31).

Operational excellence in projects

Operational excellence in projects has always been important. Leaders of major projects are now seeking project performance improvement tools and methodologies from proven practices of supply chain management. Manufacturing and service organizations tend to execute more of their activities in projects and programmes. Large-scale organizational change processes arising from mergers and acquisitions, restructuring and major information technology (IT) projects, are today carried out more efficiently by programme management. Multinational construction contractors like Bechtel, Balfour Beatty and AMEC Group are embedding operational excellence functions (e.g. Lean, Six Sigma, Performance Management) in their project and programme management organization structure. Our research has shown the activities related to operational excellence in projects, which are generally in the domain of supply chain management in projects, comprise three major areas:

- Lean project management
- Professional services automation (PSA) solutions
- Six Sigma in projects

The initiatives and processes in lean project management are deriving benefits from two sources. Firstly, the traditional approach of critical path scheduling, Basu (2004, p. 129) is to optimize time for completion and secondly derived from the lean tools applied in supply chain management (such as value stream and process mapping) to reduce procurement lead-time and non-value adding activities.

When work on a critical path stops because resources are busy elsewhere or critical resources are idle, the cause is likely to be in poor scheduling. The critical path keeps shifting because of the uncertainty of project work. Goldratt (1999) with his 'Critical Chain' and theory of constraints pointed out that the calculation of 'floats' can be misleading. The apparent buffer of time can evaporate due to preset times and allocation of resources. Building upon the concept of 'Critical Chain' lean project management developed, and it comprises three major activities:

1. Time buffers are inserted as scheduled of time into projects where non-critical paths feed into the critical path and act as shock absorbers and keep the critical path stable.
2. Projects are scheduled into the pipeline after checking the availability of resource constraints to ensure that schedules are feasible.
3. Buffer consumption is monitored and tasks feeding into the 'most empty' buffers are given first priority.

Lean project management principles may have provided good measures to deal with the uncertainty of project work, but its apparent complexity is pushing project managers towards the lean approaches of supply chain management. This lean thinking approach to minimize waste in project supply chain is championed by the Lean Construction Institute (LCI) (www.leanconstruction.org). The goal is to build the project while maximizing value, minimizing waste and pursuing perfection for the benefit of all project stakeholders. Pinch (2005) explains that LCI aims are primarily focused on the reduction of the waste, as defined by the seven categories of 'Mudas', caused by unpredictable workflows. The Mudas or wastes identified by Taiichi Ohno (1973) are:

- Excess production (no stock piling of finished goods)
- Waiting (no buffer stocks between processes, no idle time)
- Conveyance (reduce movement to a minimum)
- Motion (adoption of ergonomic principles)
- Process (Deming claimed that 90 per cent of waste is due to poor processes)
- Inventory (materials should arrive just as required and flow like water through the system to the end user)
- Defects (the aim is zero defects. It is cheaper to do things right the first time)

This approach has been defined as lean construction. By first focusing on workflow, lean construction unplugs clogs in the project stream and gradually planning, design, construction, delivery and closure of the project are better co-ordinated to deliver maximum value for the project owner. Ballard (2001) has proposed a method of reducing cycle time in home building projects within the context of even flow production. His innovation is the formation of multi-craft teams to overlap activities in each phase of the project and also reduce activity durations through time studies. The principles of lean construction are almost identical to those of a lean supply chain as discussed in Chapter 13.

Case example: Lean project management

Morris and Spottiswood is a property solutions business established in 1925 based in Glasgow, Edinburgh and Manchester. The company provides innovative solutions within clients' property space. This is delivered primarily through partnering relationships with leading retail, financial and public sector organizations.

Morris and Spottiswood ran its first lean project management in 2002/2003. The project's scope was to investigate the annual expenditure of externally hired plant. Using techniques such as Pareto analysis, value stream mapping, cause and effect and implementation planning, a cross function team investigated existing processes and established improvements that led to delivery of short, medium and long-term benefits to the business.

The quantifiable savings resulting from the lean project management was approximately £200,000 in the first year.

Source: Scottish Enterprise, Glasgow (2006)

The applications that support project-based processes within an organization are commonly referred as PSA solutions. PSA solutions appear to be very much in vogue in project performance improvement at the moment. PSA solution comprises a range of specific modules that combine to provide a solution to manage the entire project lifecycle. The integrated nature of the PSA modules supports and enhances the flow of real-time information throughout a business collecting detailed transactional data accurately and turning it into business knowledge that can be shared to business benefit. PSA solutions are offered to project organizations as functional packages such as customer relationship management (CRM), human resources management (HRM), project delivery management (PDM), project execution management (PEM), project cost management (PCM), etc.

In a recent survey Cap Gemini (2005) surveyed a number of projects where PSA solutions had been used. On each solution the following four areas were addressed:

1. Internal perspective (the organization features of the PSA vendor)
2. External perspective (customer side of the solution)
3. Technical perspective (technical aspects of the system)
4. Functional perspective (how well the solution fulfilled the requirements of process areas)

Their report showed that 42 per cent of PSA vendors had disappeared in the last 5 years but most of the solutions had been adopted by new vendors. Our critical observation on PSA solutions is that they are useful data management systems but the effectiveness in achieving operational excellence in projects depends on how their outputs are used for project performance improvement. The demise of 42 per cent vendors in 5 years indicates a moderate success rate of PSA solutions.

Interest in Six Sigma is growing rapidly within the professional project management community, and the most common question coming from that group is something like 'How does Six Sigma relate to the Project Management Body of Knowledge (PMBoK)?' Gack (2006) concludes that Six Sigma and PMBoK do have connections, similarities and distinctions and it is clear that Six Sigma complements and extends professional project management, but does not replace it. Both disciplines make important contributions to successful business outcomes. As described in Chapter 16, the core methodology of Six Sigma, that is DMAIC (Define, Measure, Analyse, Improve and Control) is closely linked to the methodology, rigour and stages of life cycle of project management.

Even today project managers are not comfortable with embracing Six Sigma in managing their projects and their arguments include that a project is unique and one-off and does not have a stable process and Six Sigma is only effective in repetitive stable processes. They also question, do we need data driven statistics of Six Sigma in projects where contractors are busy just doing their jobs? Our response to these doubts is that Six Sigma can be very effective if the tools and methodology are applied appropriately (fitted to purpose). In 'Quality Beyond Six Sigma' (Basu and Wright, 2003), Chapter 8 'Project Management and FIT SIGMA' addresses the issue of fitness for purpose. In projects we have many repetitive processes and/or we have many processes requiring design. In both situations DMAIC or DFSS (Design for Six Sigma) can be applied. However, the caveat is the appropriateness and for this reason we recommend Six Sigma methodology to larger projects with a longer duration, projects with large management organizations or multinational contractors.

DMAIC has added the rigour of project life cycle to the implementation and closeout of Six Sigma projects. Figure 16.6 shows the relationship between DMAIC with a typical project life cycle.

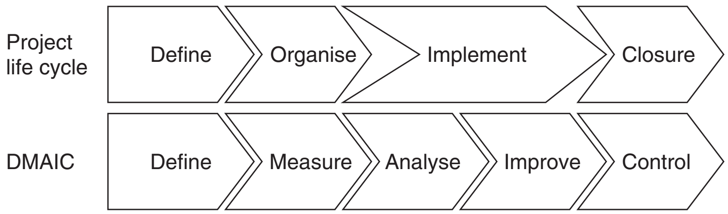

Figure 16.6 DMAIC life cycle and project life cycle.

Project organizations are showing positive interests in Six Sigma and courses and conferences are on offer for project members. Bechtel was one of the early users of Six Sigma in delivering their multinational projects as the following case example illustrates.

Case example: Six Sigma at Bechtel

Founded in 1898, Bechtel is one of the world's premier engineering, construction, and project management companies. Forty thousand employees are teamed with customers, partners and suppliers on a wide range of projects in nearly 46 countries.

Bechtel has completed more than 22,000 projects in 140 countries, including Hoover Dam, the Channel Tunnel, Hong Kong International Airport, the reconstruction of Kuwait's oil fields after the Gulf War and Jubail industrial city.

Bechtel was the first major engineering and construction company to adopt Six Sigma, a data-driven approach to improve efficiency and quality. Although it was originally developed for manufacturing companies, the company was confident that Six Sigma would work in professional services organizations such as Bechtel. Six Sigma has improved every aspect of Bechtel's business, from construction projects to regional offices, saving time and money for both customers and the company.

Six Sigma uses a rigorous set of statistical and analytic tools to produce dramatic improvements in their work processes (see Basu and Wright, 2003). Bechtel launched Six Sigma in 2000, when the company was experiencing unprecedented growth – and facing corresponding process challenges. The company has now implemented Six Sigma in its key offices and business units around the world. About half of its employees have had Six Sigma training, and most of its major projects employ its methods from start to finish.

The investment of Bechtel in Six Sigma reached the break-even point in less than 3 years, and the overall savings have added substantially to the bottom line, while also benefiting customers. Some examples:

- On a big rail modernization project in the UK, a Bechtel team used Six Sigma to minimize costly train delays caused by project work and reduced the 'break in' period for renovated high-speed tracks.
- At a US Department of Defense site in Maryland, Six Sigma helped achieve significant cost savings by streamlining the analysis of neutralized mustard gas at a project to eliminate chemical weapons.
- To speed up the location of new cellular sites in big cities, Bechtel developed a way to let planners use computers to view video surveys of streets and buildings, making it easier to pick the best spots.
- In a mountainous region of Chile, Six Sigma led to more efficient use of equipment in a massive mine expansion, with significant cost savings.

'Six Sigma is the most important initiative for change we have ever undertaken. We are happy to report that it is becoming "the way we work".'

Source: www.bechtel.com (2006)

Summary

Longer supply chains in major projects with durations over several years will mean more dependence on other companies and contractors and so collaboration throughout the project supply chain is becoming a must as opposed to traditional adversarial relationships. Indeed, competitive advantage is increasingly coming out of the ability to challenge assumptions and deliver projects on time in collaboration with project partners. In this chapter, we demonstrated with case examples how the principles of supply chain management including the approaches of operational excellence can and should be applied in projects, especially major projects dealing with several contractors over a number of years, to achieve sustainable, efficient and effective results. The communication and management of stakeholders in a wider community network of a project supply chain still remains a challenge.

We propose that a dedicated supply chain manager should be deployed immediately after the authorization of major project to manage supply chain activities over the total life cycle of the project. The supply chain manager should assume a function role, similar to a risk manager or a quality manager, reporting to the Project Director to oversee supply chain activities including supplier partnership, forecasting and scheduling, ERP and PSA systems (where appropriate) and other operational excellence initiatives.

Part 3: New demands and trends

Questions

1. Describe a supply chain management approach in managing a major event like an international book fair. Explain the nine-stage purchasing chain of decision in the event management.
2. Discuss the role of applying the traditional supply chain approach of manufacturing industries to a service industry such as hotel management. Explain how you would adapt the processes of supply chain building blocks in such a service environment.
3. Describe the key features of the market-based 'transactional' relationship and the longer-term 'partnership' relationship with 'suppliers'. It is unlikely that any service business will benefit from engaging exclusively in one type of 'supplier relationship', discuss this in the context of hospital services supply chain.
4. What are the common and uncommon supply chain management practices between a profit and non-profit organizations? What are your recommendations to apply the supply chain management expertise of the profit sector to the relief organizations responding to major natural or political disasters?
5. Discuss, with appropriate examples, the new growth opportunities and supply chain challenges in the emerging markets of:

- China
- India
- Latin America

6. In the Hindustan Lever Limited (HLL) case study of rural supply chain should HLL enter the informal sector in this way?
   What are the threats and opportunities of such a step?
   Should HLL roll out this business model?
   If the company rolls out this model, what do you think is needed in order to ensure success?
7. In 1997, Haier Group from China entered the market for wine coolers in the USA and captured 60 per cent of that specialized segment by 2002. What was their strategy and why was it a success? Should Haier roll out this strategy for marketing larger refrigerators in the USA?

8. Identify the role of e-business in a retail supply chain. TESCO supermarkets are selling ‘on-line’ household grocery products especially to professional workers. In which product categories does on-line sale offer greatest advantage and smallest advantage for TESCO?
9. Explain how CPFR network is assisting suppliers, manufacturers and retailers in planning and delivering products and services. Comment on the risks in rolling out CPFR in a regulated business like a pharmaceutical company.
10. What are the advantages and challenges in implementing an e-supply chain. Recommend a strategy of developing and rolling out an e-supply chain strategy in a fast-moving consumer goods (FMCGs) multinational enterprise?
11. How do you distinguish between a lean supply chain and an agile supply chain? Describe the characteristics of both a lean supply chain and an agile supply chain.
12. In the case example of Zara apparel company was the strategy a lean supply chain or an agile supply chain? Should Zara continue to roll out this business model? What additional measures would you recommend to ensure Zara’s success in future?
13. What is green supply chain? What are the roles of governments, non-government organizations (NGOs) , manufactures, retailers and consumers in ensuring a sustainable green supply chain? Comment on so-called ‘greenwash’ initiatives such as ‘carbon off setting’.
14. In the Airbus 380 case example in hindsight, which specific measures of traditional supply chain management could be applied to improve the success factors of the project?
15. What are components of the supply chain in a major project? Discuss the challenges and opportunities of applying supply change management principles in a major project.

Part 4

Integrating Supply Chain Management

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17

Systems and procedures

Introduction

We have described the components supply chain building blocks in Part 2, Chapters 4–9, highlighting the key issues, opportunities and challenges in managing a total supply chain. These features have been further explored with the current trends in Part 3. Now the key question is: how are these building blocks interfaced or integrated to provide the synergy of managing total supply chain as one unit? The processes in each building block are standardized or formalized by systems and procedures. The effectiveness of systems and procedures can be achieved by using sales and operations planning (S&OP) and performance management processes.

This chapter considers in the context of supply chain management the following three corner stones of systems and procedures:

1. Quality management
2. Financial management
3. Information and communication technology

Quality management

What is quality?

Quality has two levels, a basic level and a higher level. At the basic level common definitions 'fitness for purpose', 'getting it right first time', and 'right thing, right place, right time' apply. (These definitions have all been so over used that they are almost clichés.) An understanding of what we mean by basic level and higher levels of quality can best be explained by illustration.

Consider a bus service. What as passengers are our basic requirements? First, unless the bus is going more or less where we want to go, we would not catch it. The second requirement is timing – usually we have a time frame by which we judge a bus service. If we start work at 9 a.m. unless the bus gets us to the office before 9 we would not catch it. Another consideration will be cost. Therefore, the basic requirements in this example would be the route, the time and the cost, and depending on alternatives we would probably rank them in that order.

A bus service could meet all these requirements, (right thing, right place, right time, and right cost), but still not be a quality service. If the service was unreliable, (sometimes late, sometimes early, sometimes did not keep to the route) then we would not consider it a reliable service. But supposing the bus met all our basic requirements, got us to work on time every time and at a reasonable cost, but it was dirty, the driver was surly, the seats were hard and it leaked exhaust fumes. Then although it met our basic requirements there is no way we would describe it as a quality service.

In other words to meet our perception of quality there are certain basic requirements that have to be met, and there are certain higher order requirements that have to be met. In this case we would expect polite service, a clean bus, reasonably comfortable seating and certainly no exhaust fumes. A truly high quality service would mean that the bus was spotlessly clean, had carpet on the floor, and had piped music as well as all the other attributes. But no matter how comfortable the ride, how cheap the fare, unless the bus is going our way we shall not be interested in catching it. To have your product described as a quality product, the customer will expect higher level benefits. These higher level benefits are what gives an organization a competitive edge, and often the difference costs very little to achieve.

There are many different definitions and dimensions of quality to be found in books and academic literature. We will present three of these definitions selected from published literature and propose a three-dimensional definition of quality.

One of the most respected definitions of quality is given by the eight quality dimensions (see Table 17.1) developed by David Gravin of the Harvard Business School (1984).

The above dimensions of quality are not mutually exclusive, although they relate primarily to the quality of the product. Neither are they exhaustive.

Table 17.1 Gravin's product quality dimensions

- *Performance* refers to the efficiency (e.g. return on investment) with which the product achieves its intended purpose.
- *Features* are attributes that supplement the product's basic performance, for example tinted glass windows in a car.
- *Reliability* refers to the capability of the product to perform consistently over its life cycle.
- *Conformance* refers to meeting the specifications of the product, usually defined by numeric values.
- *Durability* is the degree to which a product withstands stress without failure.
- *Serviceability* is used to denote the ease of repair.
- *Aesthetics* are sensory characteristics such as a look, sound, taste and smell.
- *Perceived quality* is based on customer opinion.

Service quality is perhaps even more difficult to define than product quality. A set of service quality dimensions (see Table 17.2) that is widely cited has been compiled by Parasuraman et al. (1985).

Table 17.2 Parasuraman et al.'s service quality dimensions

- *Tangibles* are the physical appearance of the service facility and people.
- *Service reliability* deals with the ability of the service provider to perform dependably.
- *Responsiveness* is the willingness of the service provider to be prompt in delivering the service.
- *Assurance* relates to the ability of the service provider to inspire trust and confidence.
- *Empathy* refers to the ability of the service provider to demonstrate care and individual attention to the customer.
- *Availability* is the ability to provide service at the right time and place.
- *Professionalism* encompasses the impartial and ethical characteristics of the service provider.
- *Timeliness* refers to the delivery of service within the agreed lead time.
- *Completeness* addresses the delivery of the order in full.
- *Pleasantness* simply means good manners and politeness.

Our third authoritative definition of quality shown in Table 17.3 is taken from Wild (2002, p. 644).

Table 17.3 Wild's definition of quality

The quality of a product or service is the degree to which it satisfies customer requirements. It is influenced by:

- *Design quality*: The degree to which the *specification* of the product or service satisfies customers' requirements.
- *Process quality*: The degree to which the product or service, which is made available to the customer, *conforms* to specification.

The list of quality dimensions by both Gravin and Parasuraman et al. are widely cited and respected. However, one problem with definitions is that if time permitted the reader will find several other useful definitions and dimensions. Wild's definition of design/process quality does provide a broad framework to develop a company-specific quality strategy.

Nonetheless, one important dimension of quality is not clearly visible in the above models: the quality of the organization. This is a fundamental cornerstone of the quality of a holistic process and an essential requirement of an approved quality assessment scheme such as EFQM (European Foundation of Quality Management). Therefore, a three-dimensional model of quality has been developed (Basu, 2004) as shown in Figure 17.1.

Figure 17.1 Three dimensions of quality.

When an organization develops and defines its quality strategy, it is important to share a common definition of quality and each department within a company can work towards a common objective. The product quality should contain defined attributes of both numeric specifications and perceived dimensions. The process quality, whether it relates to manufacturing or service operations, should also contain some defined criteria of acceptable service level so that the conformity of the output can be validated against these criteria. Perhaps the most important determinant of how we perceive sustainable quality is the functional and holistic role that we as individuals have within the organization. Organization quality can only germinate when the approach is holistic and a single set of numbers based on transparent measurement is emphasized with senior management commitment. We have compiled (see Table 17.4) a set of key organization quality dimensions.

Hierarchy of quality

With the subject of quality, like many management subjects such as marketing, and strategic management, a number of technical terms have evolved. In some cases rather than helping us to understand the underlying concepts or techniques, technical terms tend to add a further complication to our understanding. Often the terms used are given different connotations by different people, the meanings become blurred, and terms become interchangeable. In this section we discuss the various ways in which quality can be managed. We also

Table 17.4 Basu's organization quality dimensions

- *Top management commitment* means that organizational quality cannot exist without the total commitment of the top executive team.
- *Sales and operations planning* (*S&OP*) is a monthly senior management review process to align strategic objectives with operation tasks.
- *Single set of numbers* provides the common business data for all functions in the company.
- *Using appropriate tools and techniques* relates to the fact that without the effective application of appropriate tools and techniques, the speed of improvement will not be assured.
- *Performance management* includes the selection, measurement, monitoring and application of key performance indicators.
- *Knowledge management* includes education, training and development of employees, sharing of best practice and communication media.
- *Teamwork culture* requires that teamwork should be practised in cross functional teams to encourage a borderless organization.
- *Self-assessment* enables a regular health check of all aspects of the organization against a checklist or accepted assessment process such as EFQM.

discuss the strengths and weaknesses of each method. For these reasons we have developed a hierarchy of methods of quality management. Our hierarchy approximates the evolution of quality management from simple testing to a full total quality management (TQM) system.

Quality by inspection

Traditionally in manufacturing the concept of quality was conformance to certain dimensions and specifications, the cliché being 'fitness for purpose'. Quality control was achieved by inspection and supervision. Inspection is the most basic approach to quality. The aim being for an inspector to detect, and if sufficiently serious to reject before despatch if a product deviates from a set standard. Inspection will at least provide the customer with an acceptable product. Quality inspection is an expensive method of achieving a basic level of quality. It requires the employment of people to check on the operators. Inspection and supervision does not add value to a product, but does add to the cost!

The stage of production where the inspection takes place is important. If the only inspection is at the end of the production line then, if deviations from the standard are discovered at this late stage the cost of reworking could well double the cost of the item. If a deviation from standard is not detected, the final inspector is the customer, by which time it is too late. If the product is found to be below standard by the customer, the manufacturer has the problem of putting it right. Putting right could include the cost of scrapping the unit and giving the client a new one, or in extreme cases a total product recall with all the costs and loss of consumer confidence that this entails.

Quality inspection at a more advanced level includes checking and testing at various stages of production so that errors can be detected early and remedial action taken before the next stage of the process takes place. At a still higher level of inspection materials are inspected on receipt and then probably tested again before being drawn from the store. Of course all these tests and checks take time and cost money. The cost is easy to quantify when the checks are carried out by people whose prime job is to test and check the work of others.

It is our contention that when people know everything they do is subject to testing and checking, then the onus is no longer on them to get the job right first time and they come to rely on the inspector. We believe that the inspector or supervisor will be conditioned to find a percentage of errors, after all that is the main reason for employing inspectors. This attitude will be reinforced further by an error percentage being built into the standard costs. Thus, a level of error becomes accepted and is built into the cost of the product.

The costs of relying on inspection by people other than the operator are therefore twofold:

1. A level of error becomes accepted as standard and is included in the price, and
2. Inspectors do not add value to the product. Inspectors are an added cost.

The next stage above quality inspection can be designated quality control.

Quality control

With quality control, the aim is not only to monitor the quality at various stages of the process but to identify and eliminate causes of unsatisfactory quality so that they do not happen again. Whereas inspection is an 'after the fact' approach, quality control is aimed at preventing mistakes. With quality control, you would expect to find in place drawings, raw material testing, intermediate process testing, some self-inspection by workers, keeping of records of failure, and some feedback to supervisors and operators of errors and percentage of errors. The end aims are to reduce waste by eliminating errors and to make sure that the production reaches a specified level of quality before shipment to the customer.

Quality assurance

Quality assurance includes all the steps taken under quality control and quality inspection. It includes, where appropriate, the setting of standards with documentation for dimensions, tolerances, machine settings, raw material grades, operating temperatures and any other safety quality or standard that might be desirable. Quality assurance would also include the documentation of the method of checking against the specified standards. Quality assurance generally includes a third-party approval from a recognized authority such as the ISO (International Organization for Standardization). However, ISO accreditation in itself does not suggest that a high level of quality has been reached. The only assurance which ISO accreditation gives is that the organization does have a defined level of quality and a defined procedure which is consistently being met. With quality assurance one would expect to move from detection of errors to correction of process so as to prevent errors. One would also expect a comprehensive quality manual, recording of failures to achieve quality standards and costs, use of Statistical Process Control (SPC), and the audit of quality systems.

Total quality management

The fourth and highest level in our hierarchy of quality is TQM. The lower levels of quality inspection, quality control and quality assurance are aimed at achieving an agreed consistent level of quality, first by testing and inspection, then by rigid conformance to standards and procedures, and finally by efforts to eliminate causes of errors so that the defined accepted level of quality will be achieved. This is a cold and sterile approach to quality. It implies that once a sufficient level of quality has been achieved, then apart from maintaining that level which in itself might be hard work, little more need to be done. This is often the western approach to quality and has its roots in Taylorism (see Taylor, 1947). Taylor believed in finding the 'best method' by scientific means and then establishing this method as the standard. This approach is top down, the bosses determine the level of quality to be achieved, and then the bosses decide on the best method to achieve the desired level of quality. Control methods of inspection and supervision are then set in place to ensure that the required level of quality is maintained. This does not mean that management is not taking into account what the customer wants or is ignoring what the competition is doing. It just means that they, as managers, believe they know what is best and how this can be achieved. To this end, supervision and inspection become an important method of achieving the aim with little input expected from the workers.

TQM is on a different plane. TQM does, of course, include all the previous levels of setting standards and the means of measuring conformance to standards. In doing this, SPC will be used, systems will be documented, and accurate and timely feedback of results will be given. With TQM, ISO accreditation might be sought, but an organization that truly has embraced TQM will not need the ISO stamp of approval.

Any organization aspiring to TQM will have a vision of quality which goes far beyond mere conformity with a standard. TQM requires a culture whereby every member of the organization believes that not one day should go by without the organization in some way improving the quality of its goods and services. The vision of TQM must begin with the chief executive. If the chief executive has a passion for quality and continuous improvement, and if this passion can be transmitted down through the organization, then, paradoxically, the ongoing driving force will be from the bottom up.

Generally, it is the lower-paid members of the organization who will physically make the product or provide the service, and it is the sum of the efforts that each individual puts into their part of the finished product which will determine the overall quality of the finished article. Likewise, generally it is the lower-paid staff members, such as shop assistants, telephone operators, and van drivers who are the contact point with the customer, and the wider public.

They, too, have a huge part to play in how the customer perceives an organization. It is on the lower level that an organization must rely for the continuing daily level of quality. Quality, once the culture of quality has become ingrained, will be driven from bottom up, rather than achieved by direction or control from the top. Management will naturally have to continue to be responsible for planning and for providing the resources to enable the workers to do the job. But, unless the factory operators, the telephone operators, the cleaning staff, the sales assistants, the junior accounts clerk, and the van driver are fully committed to quality, TQM will never happen.

TQM, however, goes beyond the staff of the organization – it goes outside the organization and involves suppliers, customers and the general public.

Once a relationship has been built with a supplier, that supplier is no longer treated with suspicion, or in some cases almost as an adversary. Instead of trying to get the best deal possible out of the supplier, the supplier becomes a member of the team. The supplier becomes involved in the day-to-day problems and concerns of the organization and is expected to assist, help and advise. The supplier becomes part of the planning team. Price and discounts will no longer be the crucial issues, delivery of the correct materials at the right time will be the real issues, and suppliers will be judged accordingly. Once a supplier proves reliable, the checking and testing of inwards goods will become less crucial. Ideally, the level of trust will be such that the raw materials can be delivered direct to the operator's work place rather than to a central store.

Consider the difference to your organization if the raw materials were always there on time, were of the right quantity and quality, and were delivered to the operator's work place and not to a store; each operator knew the standards and got the job right first time every time; and so on right down the line. Then the organization would not need anyone involved in checking anyone else's work. Supervisors and middle management would no longer be policing each step of a job.

At the end of the process is the customer. TQM organizations are very customer-conscious. As the supplier is regarded as part of the team so too is the customer. This is more than just wishy-washy slogans such as 'the customer is always right'. This means really getting alongside the customer and finding out exactly what they want. The ultimate is that the customer, like the supplier, becomes part of the process.

Case example: Toyota 72-hour car

An example of the way the world is moving can be found with Toyota where the aim is the 72-hour car. With the 72-hour car the customer orders a new vehicle, the materials are ordered and the car is made and delivered to the customer, all within 72 hours. This allows the customer, within a range of options, to select the car of their choice, and the customer really does become part of the supply chain. The customer's order goes direct on-line to the suppliers and to the factory. Thus the customer triggers the raw material order for all the components required for the car and also the customer's order updates the manufacturing schedule for the factory. Taiichi Ohno of Toyota says that his current project is 'Looking at the time line from the moment the customer gives us an order to the point where we receive the cash. And we are reducing the time line by removing the non-value wastes'.

What does this mean? It means no more raw material stockpiling, no more stocks of finished goods, reduction in needs for capital, storage space, and insurance, and it means that the customer is getting what she or he really wants (such as colour, upholstery, sound system, engine size, and countless other options as specified by the customer). Obviously, a system such as the Toyota process does not, and cannot, make allowances for mistakes. A system such as this relies on good planning by management, quality designed into the product, well-trained workers who are empowered to work as a team, suppliers who are trusted to supply when required and who are also part of the team, an integrated computer system, and as Taiichi Ohno says, the elimination of non-value wastes.

We are now then looking at a totally new type of organization: the old bureaucratic style of management, with the associated rules relating to span of control, appraisal systems, and incentive schemes is simply no longer appropriate. Instead, organizations have to be designed around the process. For example, instead of having a centralized purchasing department, why could not the operator, or a group of operators on the shop floor, phone, fax or e-mail through the daily order to the supplier (and for the materials to be delivered directly to the line rather than to the store). If each group of operators around a process were working as a team, why would a large central human resources department be needed? Certainly, the operating team itself would not need a supervisor. Maybe a team leader would be necessary to hurry management along and to ensure that management planning was sensible. The aim here is not for the front-line operators to be working harder but for them to take control and accept responsibility for their operation. It does not mean fewer people turning out more, but it does mean the elimination of several levels of management and it does get rid of the matrix of responsibility for human resource and other 'service' or staff departments as shown on the old-fashioned organization charts. With fewer levels of management, communication becomes less confused, and responsibilities (and areas of mistakes) become much more obvious.

For TQM to work, a company has to go through a total revolution. Many people, especially middle managers, have to be won over. Workers, too, have to want to accept responsibility. TQM will mean a change of culture.

The cost of TQM can be measured in money terms. The emphasis will be on prevention rather than detection, thus the cost of supervision and inspection will go down. Prevention cost will go up because of the training and action-orientated efforts. But the real benefits will be gained by a significant reduction in failures – both internal (e.g. scrap, rework and downtime) and external (handling of complaints, servicing costs and loss of goodwill). The total operating cost will reduce over time (say 3–5 years) as shown in Figure 17.2.

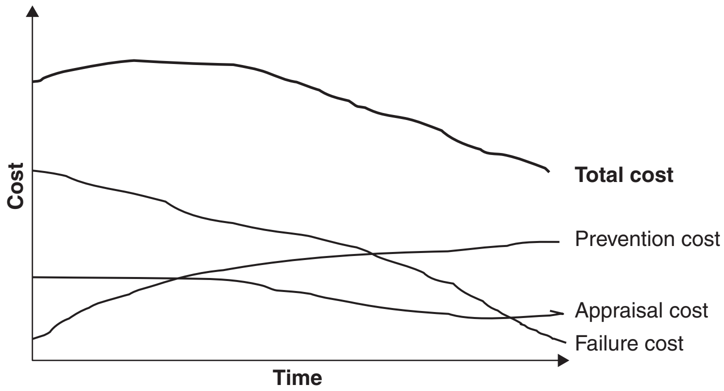

Figure 17.2 Total cost of quality.

The adoption of a standard such as ISO 9000 (for further details see the International Organization for Standardization) rather than streamlining an organization might actually serve to increase the need for audits and supervision. ISO 9000 to this extent can therefore be seen to be contrary to the philosophy of TQM. With TQM staff members are encouraged to do their own checking and to be responsible for getting it right first time and the need for supervision becomes almost superfluous. With ISO 9000, the standard method will likely be set by management edict and, once set in place the bureaucracy of agreeing and recording improvements may stultify creative improvements.

ISO tends to be driven from the top down and relies on documentation, checks, and tests to achieve a standard, somewhat bland, level of quality assurance. TQM on the other hand, once established, relies on bottom-up initiatives to keep the impetus of continual improvement. However, as the Deming method of TQM does advocate a stable system from which to advance improvements, the adoption of the ISO 9000 approach will mean that there will be a standard and stable system. To this extent, ISO 9000 will prove a useful base for any organization from which to launch TQM.

As shown in Figure 17.3, ISO 9000 can be depicted as the wedge that prevents quality slipping backwards, but the danger is it can also be the wedge that impedes progress.

Notwithstanding the benefits of obtaining a standard stable system through ISO procedures, it must be queried why a true quality company would need ISO 9000. If the customer or potential customer is *not* insisting in ISO accreditation, then the time and effort (and the effort expended will be a non-recoverable cost) makes the value of ISO to an organization highly questionable.

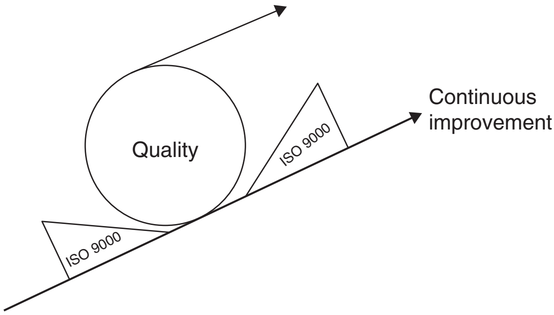

Figure 17.3 The wedge.

Gaining ISO 9000 accreditation is a long and expensive business. Internally it requires much time and effort, and most organizations underestimate the time and effort involved. Generally, recording the systems alone will require the full-time efforts of at least one person.

TQM to FIT SIGMA™

> *Today, depending on whom you listen to, Six Sigma is either a revolution slashing trillions of dollars from corporate inefficiency, or it's the most maddening management fad yet devised to keep front-line workers too busy collecting data to do their jobs.*
>
> USA Today (21 July 1998)

It has been several years since the above statement was made. During this time the 'Six Sigma revolution' has created a huge impact in the field of Operational Excellence, yet conflicting views are still prevalent.

Let us evaluate the arguments for both sides. On a positive note, the success of 'Six Sigma' in General Electric (GE) under the leadership of Jack Welch is undisputed. In the GE company report of 2000 their CEO was unstinting in his phrase: 'Six Sigma has galvanized our company with an intensity the likes of which I have never seen in my 40 years of GE'. Even financial analysts and investment bankers compliment the success of Six Sigma in GE. An analyst at Morgan Stanley Dean Witter recently estimated that GE's gross annual benefit from Six Sigma could reach 5 per cent of sales and that share value might increase by between 10 and 15 per cent.

However the situation is more complex than such predictions would suggest. In spite of the demonstrated benefits of many improvement techniques such as TQM, business process re-engineering (BPR) and Six Sigma, most attempts by companies to use them have ended in failure (Easton and Jarrell, 1998). Sterman et al. (1999) conclude that companies have found it extremely difficult to sustain even initially successful process improvement initiatives. Yet more puzzling is the fact that successful improvement programmes have sometimes led to declining business performance causing lay offs and low employee morale. Motorola, the originator of Six Sigma, announced in 1998 that its second quarter profit was almost non-existent and that consequently it was cutting 15,000 of its 150,000 jobs!

To counter heavyweight enthusiasts like Jack Welch (GE) and Larry Bossidy (Allied Signal) there are sharp critics of Six Sigma. Six Sigma may sound new, but critics say that it is really SPC in new clothing. Others dismiss it as another transitory management fad that will soon pass.

It is evident that like any good product 'Six Sigma' should also have a finite life cycle. In addition, Business Managers can be forgiven if they are often confused by the grey areas of distinction between quality initiatives such as TQM, Six Sigma and Lean Sigma.

Against this background, let us examine the evolution of total quality improvement processes (or in a broader sense *operational excellence*) from *ad hoc* improvement to TQM to Six Sigma to Lean Sigma. Building on the success factors of these processes the key question is: how do we sustain the results? The authors have named this sustainable process as FIT SIGMA™ (see Basu and Wright, (2003).

What is FIT SIGMA? Firstly, take the key ingredient of quality, then add accuracy in the order of no more than 3.4 defects in 1,000,000. Now implement this across your business with an intensive education and training programme. The result is Six Sigma. Now let's look at Lean Enterprise, an updated version of classical Industrial Engineering. It focuses on delivered value from a customer's perspective and strives to eliminate all non-value added activities ('waste') for each product or service along a value chain. The integration of the complementary approaches of Six Sigma and Lean Enterprise is known as Lean Sigma. FIT SIGMA is the next wave. If Lean Sigma provides agility and efficiency, then FIT SIGMA allows a sustainable fitness. In addition, the control of variation from the mean (small Sigma 'σ') in the Six Sigma process is transformed to company wide integration (capital Sigma 'Σ') in the FIT SIGMA process. Furthermore, the philosophy of FIT SIGMA should ensure that it is indeed fit for the organization.

Financial management

Historically, the relationship between financial management and operations management has been like oil and water, 'them and us'. The 'quality movement' of the 1980s appeared to have encouraged some operations managers to move away from involvement in costs and measurements. Some operations managers, both in the manufacturing and service sectors took the stance that cost and measurement were 'internally focused', the concern of the 'bean counters', whereas the quality movement was externally customer focused. But in fact this was not what the quality gurus such as Deming, Juran, Crosby, Feigenbaum and Peters were saying. Their message was that measurement is important in achieving quality. For a start without a scorecard of some type it is not possible to determine if improvements are being made.

Traditionally accountants have seen themselves as the major channel through which quantitative information flows to management. Accountants work on historical data of what has happened, and their reports cover arbitrarily set periods of time, with little allowance that business activities do not stop on 30 June or 31 December (or whatever other date has been designated as the time to take a snap shot of the financial position of the business). From a conventional point of view, and from the point of view of stakeholders, such as shareholders and bank managers, there has to be a way of measuring the performance of an organization and currently there is no better method than accounting reports. It follows therefore, that for accountants to do their job of reporting to meet the conventional requirements, information will be required from the manufacturing arm of the business. This cannot be disputed. Therefore if information is being provided, then it is useful to try and use that information to improve the productivity of the organization.

In response to pressures from stakeholders there is a risk of overemphasis on short-term financial performance. Consequently this myopic approach results in overinvestment in short-term fixers and underinvestment in longer-term development plans. Furthermore, the emphasis for short-term results can cause organizations to reduce costs as a general across the board target without any effective analysis of value creating activities.

It makes sense therefore, that financial factors are integrated with operations and that operations managers can focus on the cost advantage of manufactured goods. Improved quality, delivery and flexibility should eventually improve the profit margin, but the impact of any operations cost is straight to the accountants' 'bottom line'. After all operation is responsible for an ex-works cost or ex-facilities cost which accounts for a significant part of the cost of sales. There are indications that there has been a gradual shift in operations towards financial management, probably influenced by the following factors.

The growth of the 'share owning' population has generated a new breed of consumers who are interested in the financial performance of a company. This has required financial management to become conscious of external requirements.

With the increase in external sourcing and third-party operations, the cost base and its control in manufacturing and services have been sharpened.

The economic recession in the late 1980s and early 1990s forced many manufacturing and service industries to adopt re-structuring and cost-reduction initiatives.

Finally, in the well publicized Balanced Scorecard the role of financial perspective, as one of the four perspectives, has been accepted by operations mangers since 'financial measures are valuable in summarizing the readily measurable economic consequences of actions already taken' (Kaplan and Norton, 1996).

It is therefore important for any company to focus on the key issues of financial management in order to enhance competitiveness through operations cost advantages. These issues include achieving business objectives, understanding strategic cost factors and cost effectiveness.

Achieving financial objectives

We do not intend to delve into the sophisticated world of financial management involving the method of financing, tax implications, currency movements, etc. However, as indicated earlier, it is important that key financial parameters and objectives of the business should be understood and incorporated in manufacturing objectives. Key financial concepts are:

- *Sales value*: The total turnover of the business in money terms.
- *Net profit*: The money made by the business after charging out all costs. This can be expressed before tax or after tax.
- *Capital employed*: Total investment tied up in the business comprising shareholders funds. With the double entry system of accounting, shareholders' funds, or capital, will always equal the total of all the assets less all the liabilities.
- *Working capital*: Working capital refers to the funds available, and is the difference between current assets (debtors, inventory, bank balances and cash) less current liabilities (creditors, short-term loans and the current portion of long-term loans).
- *Cash flow*: Cashflow statements show where and how the working capital has increased or decreased.

There are only four basic sources for an increase in working capital and likewise only four basic uses to explain a decrease in working capital, namely:

- Increase in working capital
  - Profits from operations
  - Sale of fixed assets
  - Long-term borrowing
  - Increase of shareholders' funds through the issue of shares
- Decrease in working capital
  - Losses from operations
  - Purchase of fixed assets
  - Repayment of long-term loans
  - Distribution of profits to shareholders (dividends)

The key financial indices influencing the financial objectives of a business are:

$$\text{Trading margin} = \frac{\text{Net profit}}{\text{Sales value}} \times 100$$

$$\text{Asset turn} = \frac{\text{Sales value}}{\text{Capital employed}}$$

$$\text{Return on investment (ROI)} = \frac{\text{Net profit}}{\text{Capital employed}} \times 100$$

Balanced sheet ratios

Balanced sheet ratios are the corner stones of Financial Accounting and are concerned with the longer tern and external requirements of creditors, shareholders, prospective investors, inspector of taxes and persons outside the management as well as with the internal requirements of the management.

Operating ratios

The operating ratios are in the domain of Management Accounting for tactical management and these ratios can be classed as follows.

1. *Sales to capital*: This ratio measures the efficiency of the use of capital. The higher sales per pound of capital the more effectively is capital being employed.
2. *Cost of sales to stock and sales to debtors*: These ratios help to assess whether stock is too high or debtors are taking too long to pay. Our example above shows that it would take 11 months at the current rate of sales to sell all the stocks. Similarly, the debtors are taking on average 4 months to pay. Whether these examples show a poor situation depends on the business and its terms of trade; at face value they would certainly seem to be excessive.
3. *ROI and return on sales*: These ratios are widely used as measures of efficiency and performance evaluation. In addition, wide use is made of ROI to assess the validity of new projects. Most companies set a minimum ROI rate that must be exceeded before a new project can be proceeded with.

In spite of some recent criticisms, ROI has continued to be the most important single index of the financial objective of a manufacturing business. Value-based management methodology is favoured by many companies today. One such performance measure is EVA (Economic Value Added), which is a trademark of Stern Stewart & Co. EVA accounts for the cost of doing business by deriving a capital charge. A positive EVA rating indicates that the company has created value.

Often firms become so focused on earnings that they lose sight of the cost of generating those earnings in the first place. EVA has become a popular tool to which the executive's bonus may be linked. It is important to note (see Appendix 1) that ROI and EVA are closely related as shown by the equation:

$$\text{EVA} = (\text{ROI} - \text{WACC}) \times \text{TCE},$$

where WACC is the weighted average cost of capital and TCE is the total capital employed.

Hamel and Prahalad (1994) attacked managers obsessed with denominators (capital employed). The right approach of manufacturing is, to identify high leverage points of both increasing profits and reducing capital employed. Low-cost manufacturing is a desirable manufacturing objective as long as the investment decisions are geared to longer-term requirements and the measures do not affect the specified standards of quality, delivery and safety. The measures indicated in the ROI improvement tree (Figure 17.4) have been covered in other sections of the book, but it is useful to focus on a total picture of cost advantages so that the inter-relationship between different elements and their relative weight can be visualized.

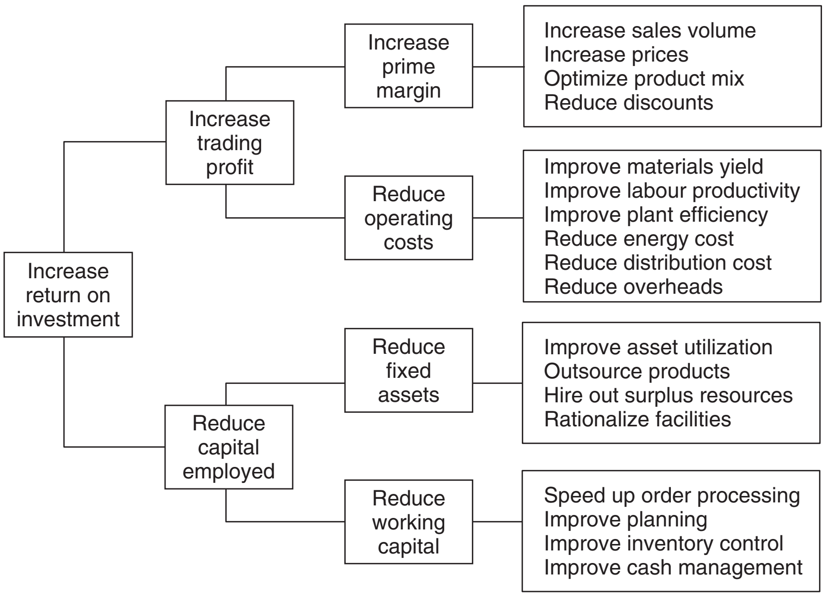

Figure 17.4 Company profitability: tree of improvement.

In special cases, simulation of cost modelling is justifiable.

The financial objectives of a business, especially in the manufacturing sector, include increasing asset turn, improving profit margin and improving ROI, but these three indices may appear to be conflicting, as shown in Figure 17.5.

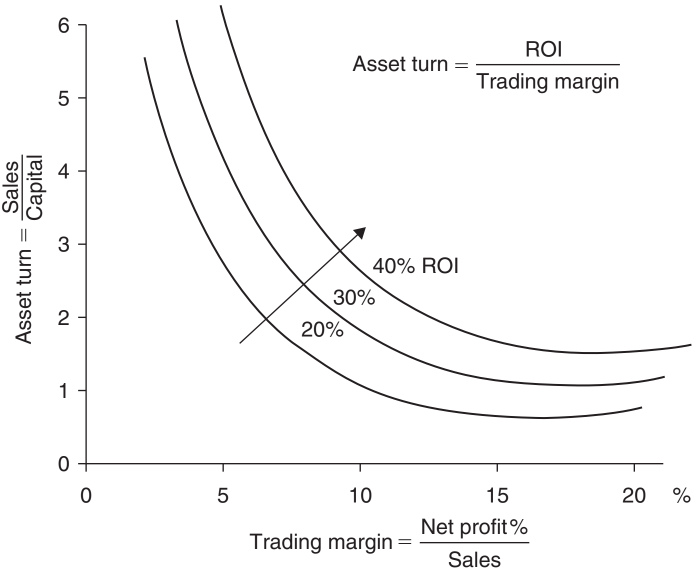

Figure 17.5 Capital assets productivity.

For a given ROI, profit margin goes down with increased asset turn and vice versa. However, when analyzed more closely by managing the improvement of both numerator and denominator (i.e. operations improvement and asset management) the company performance can move to a higher ROI curve and retain improvements in both profit margin and asset turn.

Understanding strategic cost factors

There are a number of strategic factors affecting the financial management that drive the business strategy of an organization in both manufacturing and service sectors. We shall review three areas:

1. Revenue growth by volume and product mix
2. Asset utilization and investment
3. Cost effectiveness

Volume and mix

Costs are determined by volume (including variety and variations) and investment policy. These are strategic in a sense that they relate to the way the company may decide to react to the competition and to developments in the marketplace.

Volume, in general, is good for business as the higher volume reduces the overhead or fixed cost per unit of production. However, the advantage of 'economies of scale' should not be pushed beyond the natural capacity of a site as the unit cost could go up due to constraints in site capacity and services. As variety increases, unit cost of manufacturing may also increase due to technology cost, lower utilization of plant and increased overhead/infrastructure. With flexible manufacturing variety can be essential to be competitive in segmented markets. Manufacturing should in these cases accommodate variety by incorporating higher flexibility of plant and operations. Variation is another determinant of product cost. If there are unstable variations in sales demand, supplier lead time and plant performance, then the planning effectiveness will go down and buffers in stock, capacity and resources will be necessary.

Asset utilization

It is important that formal investment appraisal procedures and investment policies are in place. However, the rate of discounted cash flow (DCF) yield should vary according to the type of investment as indicated in Table 17.5.

Table 17.5 Discounted cash flow yields

Cost reduction projects	10–25%
Capacity expansion	
Replacement	20–25%
Strategic	15–20%
New technology	10–15%
Environment and safety	0–15%

Evaluation should include all tangible benefits and intangible benefits. The above table is indicative only to demonstrate the relative importance of investments. The actual limit of DCF yield is set by each company depending on financing charges, depreciation rate for a capital asset and the life cycle of the product.

Cost effectiveness

Cost cutting or cost reduction exercises, if they are panic driven, or ‘chairman’s 5 per cent reduction target’ will only give short-term results and will cause imbalances and disruptions in operations. Other legitimate concerns will be the negative effect on quality, innovation and customer service. And although direct factory labour might account for only 5–15 per cent of the total ex-works cost (see Figure 17.6) the overwhelming emphasis usually is given to the reduction of labour cost. New and Mayer (1986) state,

> *Whole work study departments are maintained to control the direct labour content of unit cost. Yet there are many plants that spend twice as much on purchased materials as on direct labour that do not even attempt to measure purchasing performance realistically.*

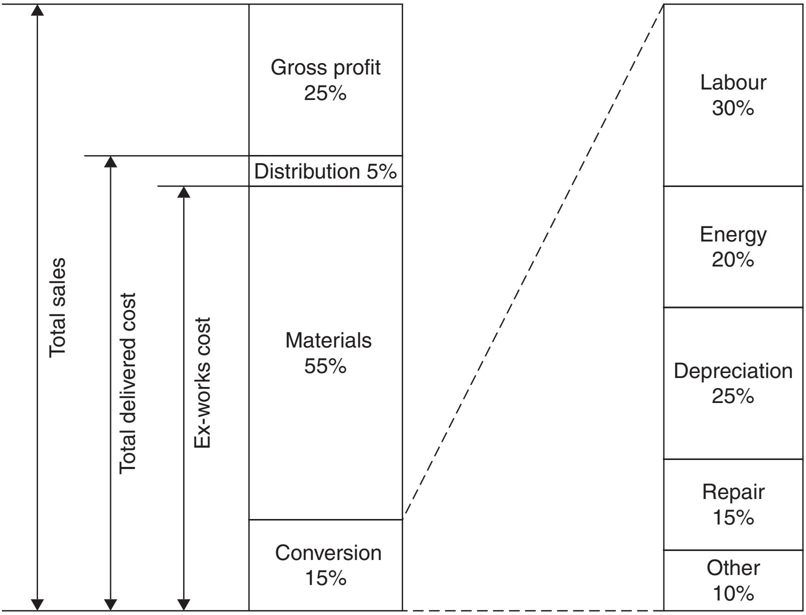

Figure 17.6 An example of cost structure.

The real business focus should be to survive and to be capable of competing in the future. Although strategy and innovation are important, the hard fact is that unless there is a positive operational cash flow the business cannot plan for the future. Therefore it is vital to have cost improvement even in a profitable company, but the approach must be cost effectiveness, not cost cutting.

The key principles of a cost effectiveness programme are:

- Understand the strategic drivers of cost, that is volume/capacity, variety and variation and their impact in the marketplace and competition.
- Evaluate the effect of any company saving measures on quality, safety and customer service.
- Identify the leverage of cost structure and set priorities of effort and 'go for gold'. But as a rough guide the amount of effort allocated to manufacturing cost reduction should be proportional to the rest of the costs of the company.
- The programme should be company wide, although manufacturing is the key player.
- The principles of value engineering should be applied in identifying and emphasizing operations where no value is added.
- Cost effectiveness is a continuous process for all manufacturing businesses, but some businesses may require a quick and significant change in their cost structure. Study teams should then be formed to carry out *ad hoc* exercises, such as big scale value analysis (BSVA), restructuring or site rationalization (including plant closure).

- Value analysis is a technique used to examine each element of a process so as to find a cheaper material or better method with the aim of maintaining or enhancing the value of the product in performance terms and at the same time reducing the cost. BSVA uses value analysis technique but in addition examines the total delivered cost (see Figure 17.6) of the business and has a short time scale (usually less than 1 year) with emphasis on company-wide implementation. The cost model in Figure 17.6 is a typical example of a fast-moving consumer good (FMCG) business and obviously the proportion of cost elements would vary depending on the product.

Accounting systems

It is vital that the company has a reliable accounting system in place to provide fast and accurate cost information. The minimum requirements should be standard costing and budgetary control.

Some companies are moving towards activity-based costing (ABC), particularly for supply chain management. The accurate cost information provided by ABC can give a company a competitive advantage. However the experience of western companies according to De Meyer and Ferdows (1990), suggests that the implementation of ABC has not been successful, perhaps due to the historical inertia of standard costing. Any half-baked implementation could be more harmful than useful.

Information and communication technology

The focus of information technology (IT) within organizations has shifted dramatically over the last 40 years from improving the efficiency of business processes within organizations to improving the effectiveness of the value chain reaching suppliers, customers and consumers. During the 1960s and 1970s, businesses focused on the use of mainframes to process large quantities of data. In the 1980 and early 1990s organizations focused on using personal desktop computers to improve personal efficiencies. The last decade with the revolution of Internet has seen the use of technologies to create electronic communication networks within and between organizations and individuals. The implementation of Enterprise Resource Planning (ERP), websites, e-commerce and e-mail systems during the past 15 years have allowed individuals within organizations to communicate together and share data. IT has now grown into information and communication technology (ICT). In this ICT foundation stone we consider two broad areas:

1. IT and systems
2. e-Business

IT and systems

IT is rapidly changing and becoming more powerful. It will be a continuing source of competitive advantages for manufacturers if used correctly. In 2007, the personal computer (PC) on the desk of an average operations manager has the capability of 1024 megabytes of main memory and 80 gigabytes of direct access storage. Ignoring the technical jargon, most of us have on our desks more computing power than the average £100 million a year manufacturing plant had 12 years ago. This IT revolution is available to everyone and how a company puts it to work will determine to a great extent its competitiveness in the global market.

The rapid growth of IT has also created problems and challenges. Many senior managers of companies lack any detailed understanding of the complexity of technology. They either follow the fashion (e.g. 'no one was fired for choosing IBM') or they are discouraged by the cost of technology, or from a lack of evidence of savings in a new field. When executives read about all the clever things seemingly low-cost computer technology can do they feel frustrated when the systems experts say, 'It will take 3 years to develop the software'. Most senior managers also feel lost in a blizzard of buzzwords.

Yet another issue is the implementation of systems to the benefit of the users. When a company looks for an IT solution to a problem without re-engineering the process, refining the existing database or training the end users, the application is doomed to fail. Real disasters can be very expensive. For example, the $60 million Master Trust accounting system for Bank of America had to be scrapped because it could not keep accurate accounts.

Figure 17.7 shows a framework of IT strategy comprising three levels of hardware strategy, software strategy and implementation strategy.

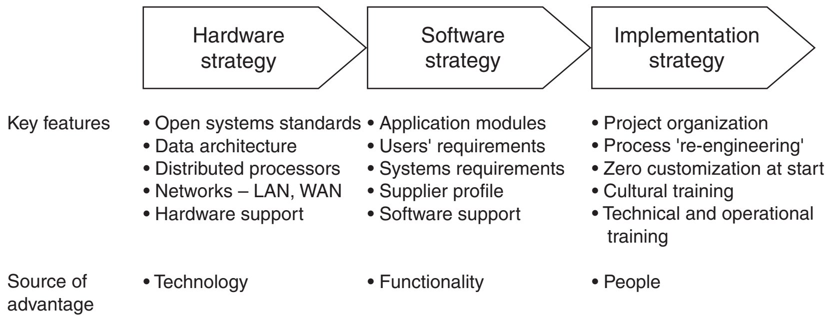

Figure 17.7 IT strategy.

IT hardware strategy

New developments towards 'open systems' standards started in 1987 when AT&T in partnership with SUN Microsystems introduced the Unix Open Look operating system. This system was used by Wang, Oracle, Olivetti and Lucky

Gold Star. Seven big computer companies led by IBM, Hewlett-Packard and DEC formed the Open Software Foundation (OSF) and introduced in 1990 their own competing standard operating system using IBM operating systems as core technology. Fortunately the interface standards of both competing standard operating systems do not differ significantly. However should there be a further polarization of the two camps it is possible that the majority of companies will follow the Open Software Foundation Application Environment Specifications (OSF AES) which operate IBM-AIX, DEC-Ultrix and HP-UX operating systems.

There are good open standards such as ANSI 92 for a relational database system which conforms to the SQL standards. The leading proprietary database systems which conform to these standards include Oracle, Sybase, Informix and Progress. In order to ensure the maximum level of portability, the future direction of new software is likely to move towards the so called three-tier architecture. For example, Tier I contains the user interface, Tier II is the functionality layer and Tier III is the database layer.

With the rapid development of application tools a proven hardware policy has been what is known as client–server computing. All ‘servers’ are open system large or mini computers (e.g. IBM-AIX) and ‘client’ computers are largely personal computers (PCs).

The benefits of standards include the creation of local area networks (LANs) and wide area networks (WANs). A LAN can cover a large industrial complex while a WAN can offer inter-site communications on a national or international basis. In the early 1990s the companies were gradually migrating from previously popular network standards (such as PC LAN, Novell, Internet) to open systems network such as NFS-based systems. However by mid-1990s Novell started to regain the market dominance.

The hardware strategy should also include the capability of local hardware support both by suppliers and the company’s own staff. The support capability may influence the selection of hardware whether IBM, HP, DEC or SUN or other. A sensible strategy is to go with the market leaders who are setting the de facto standards.

‘Legacy systems’ are older IT systems installed on central mainframe hardware and systems usually worked on one specific areas of supply chain such as purchasing or inventory management. The ERP systems, on the other hand, are supply chain IT systems that exchange information across all functions of an organization or enterprise. There are several modules of an ERP system which can be installed either stand alone or in interaction with other modules. Some of the key modules are Finance, Purchasing, Master Production Scheduling, Materials Management, Sales and Distribution, Supplier Management and Human Resourced. ERP systems clearly hold major advantages over ‘legacy systems’ in functionality, scope and flexibility of applications.

The shift of supply chain IT software systems from ‘legacy’ to ERP systems has also created a major shift of the hardware technology platform from main frames to client/server platforms. In a client/server architecture each computer or process on the network is either a client or a server. Servers are powerful computers or processes dedicated to managing disk drives (file servers), printers (print servers), or network traffic (network servers). Clients are PCs or workstations on which users run applications. Two technologies are influencing the client/server platforms. The first technology is the browser-based Internet application. The second one is the new model of application service providers (ASPs) who host software developed by others and rent it to companies.

IT software strategy

At the early stage of IT, applications software was limited to financial and commercial areas. Now a company is faced with a bewildering array of software ranging from design/process engineering, to manufacturing, to supply chain, to administration. Versions of specific software and systems technology will continue to change. Therefore it is vital that a manufacturing company formulates a software strategy by careful planning.

The first step is to identify the areas of application depending on the activities size and priorities of the company. Figure 17.8 shows a framework of application software in five key areas, namely financial administration, supply chain management, factory administration, and 'client' workstation. The traditional computing modules of accounts and payroll are in financial management. The biggest area of application is in supply chain management starting

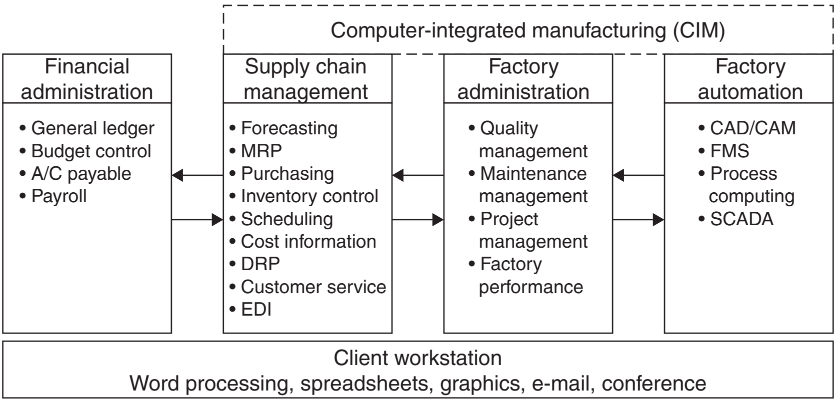

Figure 17.8 Application software modules.

from sales forecasting to customer service and electronic data interchange (EDI). At the factory shop floor there are two application areas, namely factory administration – comprising management information systems – and factory automation – comprising design, process engineering and automation of equipment. The software for client workstations is PC based (usually supplied by two large global suppliers – Microsoft and Lotus) covering word processing, (e.g. Word for Windows) spreadsheets, (e.g. Lotus 1-2-3, Excel) computer graphics (e.g. Powerpoint), multi-tasking (e.g. Windows XP), e-mail and conference (e.g. Lotus Notes). During the late 1980s many manufacturing companies searched for one turnkey package and invested in what is known as computer-integrated manufacturing (CIM) with limited success. If a company follows an 'open systems' policy for hardware and relational database then different proprietary software packages stand a better chance of being interfaced and database information can be shared in a client–server environment. Probably their most significant advantage is in the enterprise wise view of a business that ERP (enterprise resource planning) systems allow. However, ERP systems have a number of disadvantages. Apart from being costly and difficult to implement they are usually inflexible and lack integration to the systems of other organizations within a value chain. This means that only some benefits from networking technologies are captured.

The software policy should include standard packages for the company in specific areas of application. The selection of software should conform to the key criteria of user requirements, systems requirements, supplier profile and software support. The earlier examples of applications software were relatively inflexible and the approach was 'systematize the customer' rather than 'customize the system'. Many disillusioned customers attempted to build their own software and burnt their fingers in the process. In the present climate the software tools have become flexible, the IT is advancing rapidly, competitive expert support is provided by specialist software houses and thus it is prudent to buy appropriate software rather than to develop your own (see Figure 17.9). The software should conform to open systems requirements and the supplier should be both reputable and locally available for support. The company should also build up its own IT support staff, especially a 'user support' service.

There is a major conflict in developing a software strategy between a 'best of breed' approach and a 'single integrator' approach. In a 'best of breed'

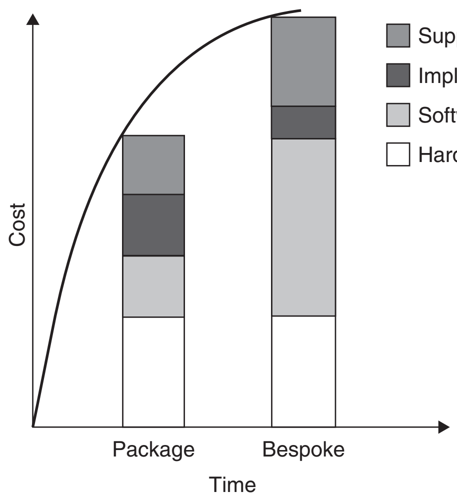

Figure 17.9 Software development strategy.

approach the best functionality solution of each individual function is chosen and companies attempt to integrate different types of systems. Although the company is likely get the best solutions in each area but the problems of integration often offset the advantages of best solutions. ERP providers offer flexible modules that allow a single integrated framework of different functions of a supply chain stage. A single integrator approach also offer the advantage of technical support and maintenance contract with a single source supplier.

Implementation strategy

The success of an IT strategy depends as much on the selection of appropriate hardware and software as on their implementation.

Similar to a company-wide programme such as TQM, the implementation must have top management commitment. This should be reflected in setting up a project team comprising members from users (marketing, logistics, manufacturing, accounts) and business systems. The project manager is usually chosen from the main user group. For example, if the application software is for supply chain management then the project manager should ideally have a logistics background.

The project team should receive both technical training (e.g. Unix, Oracle) and operational training (functionality of the software). The project manager then prepares a clearly stated action plan with target dates and resources for key activities. The plan must include review points and steering by the members of the board.

It is essential that the existing procedures and processes are thoroughly and systematically reviewed. There are various tools for analyzing the flow and requirements of the existing systems. SPC techniques are widely used. Nowadays some companies are using computer-aided software engineering (CASE) tools to analyze the structure, database and flows of the existing process and compare them with the proposed software for implementation. With the success of the BPR approach of Hammer and Champy (1993), some companies are using an IT application as a catalyst and applying the principles of BPR to re-engineer the total business processes of the company. The approach should depend on the depth and breadth of the application systems, but there is no doubt that the existing systems must be reviewed and refined when implementing a new system.

One important rule is that the user should not try to customize the system at the outset. Often after acquiring experience on the new system the user may find that the need and nature of customization could be different. However it is necessary that a ‘prototype’ is tested for a new system using the company’s own data.

After the training of the project team the training programmes should be extended to all potential users of the system. The training features should contain both cultural education to establish acceptance by everyone concerned and operational training to understand the functionality and operations of the new system. Training documents are designed specifically for the users’ needs.

The next stage is the data input and 'dry run' of the new system in parallel with the existing system before the system goes live. There are benefits of forming users' group for exchanging experience with users drawn from within and from outside the company.

e-Business

It would appear, from today's press, that all business problems can be solved by e-business whilst, at the same time, they blame all business failures and any economic downturn on e-business as well! Given the volume of news items, it may appear that defining 'e-business' is to state the obvious. Or is it?

It is apparent that very often all e-business is perceived as a collection of pure play dot.com organizations. Such an 'umbrella view' means the distinctions between e-commerce, e-marketplace, and e-business are poorly interpreted. For example, the most popular perception of e-business is on-line shopping – 'workaholics' pointing their browser at Amazon.com to order an emergency present because they forgot someone's birthday again.

Let us clarify some items. e-commerce is the transactional electronic exchange for the buying and selling of goods and services.

The 'e-marketplace' is the on-line intermediary for electronic transactions between buyers, sellers and brokers. This is also referred to as the Digital Marketplace, Portals or Hubs.

Early opportunities were observed in the enabling infrastructures and Internet-based networks (Internet, Intranet and Extranet), replacing existing telephone, fax and EDI networks. The early success of e-procurement vendors (e.g. Commerce One, Ariba, Info Bank) was well received. The old suppliers suffered many problems including that of authorization with no conformity of systems between business partners. It was like having different telephone systems for each of the people to whom you speak. This has been transformed by Trading Portals that interconnect the contents of different suppliers and making them usable by all buyers.

In a recent report, Basu (2003) the complex web and infrastructure of e-business applications have been simplified as shown in Figure 17.10 to illustrate the 'building blocks'.

There are five key types of e-business application systems that enable businesses to trade and conduct electronic transactions or communications. These are:

1. e-Commerce solutions for both sell side and buy-side applications.
2. Market making applications that enable multiple buyers and sellers to collaborate and trade.
3. Customer relationships management (CRM) solutions to facilitate improved business partnerships with customers.
4. ERP solutions for site-based planning and execution of operations.
5. Supply chain management solutions for optimizing the demand and supply in the total supply network including the suppliers.

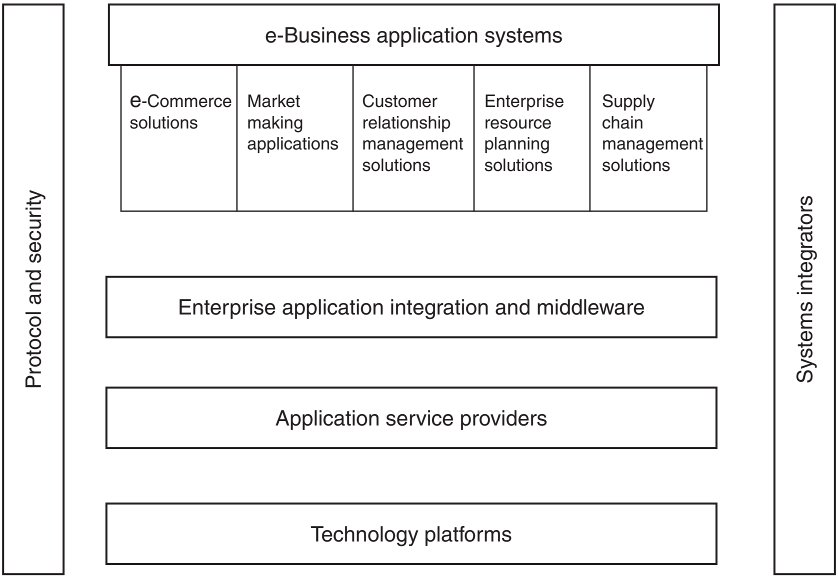

Figure 17.10 e-Business building blocks.

In order to support the interfacing and integration of application systems, there are technology building blocks. These include Enterprise Application Integration (EAI) and middleware applications, ASPs and Technology Platforms.

e-Commerce solutions

The buy-side applications of e-commerce, initially targeted at larger buyers, enable companies to levy across new or existing vendors. Solutions are increasingly aiming at integrating ERP systems with the organization's own suppliers and customers. The new application developers are utilizing the opportunities created by the lack of integration of ERP systems with other Internet systems and outside companies.

Initially the buy-side application vendors (including Commerce One and Ariba) were driven by pure play solutions for the purchase of MRO (maintenance, repairs and operations) or indirect goods. The huge potential of e-procurement offered up by 'pure companies' has been recognized and seized by established ERP vendors such as SAP and Oracle, and software vendors like Netscape and Datastream.

The buy-side vendors, whether pure play or not, are focussing on packaged buy-side application suites and looking to move into the direct procurement area. This requires a greater degree of understanding of business processes in specific industries and rigorous validation of the data processing.

The sell-side application vendors are looking to provide services content management and transaction processing. Hence, there are some sub-categories of software within this group. These include cataloguing, profiling, configurations and payment technologies. As a result, this sector is highly fragmented. There is a close interface with CRM solutions.

There are three broad categories of vendors in the sell-side market. They are (a) dominant software houses (e.g. IBM, Microsoft, AOL), (b) ERP vendors (e.g. Oracle, SAP) and (c) EDI vendors and B2C vendors (e.g. Harbinger, Broadvision).

Market making applications

There are broadly two types of market making applications. The first allows businesses to buy or sell by on-line auctions or bidding. Buyers place an open order to purchase an item and the sellers have the opportunity to bid. The second mechanism is the exchange or two-way auction platform containing a high-speed bid/ask bartering process.

ERP applications

Internet technology has certainly enhanced the collaborative business culture by enabling on-line transparent information and transactions. The company-centric enterprise application vendors (including SAP, Oracle, J D Edwards and PeopleSoft), are now building partnerships or alliances with supply chain vendors (e.g. Manugistics, i2) and looking to extend their customer relationship applications and e-commerce solutions out into the web.

CRM solutions

It is fair to state that most businesses regard the retention of customers as an important goal and therefore the criteria of CRM are not new for most enterprises. However, the collaborative Internet-based network has enhanced the need for customer intimacy and personalization. A number of software solutions have been developed (e.g. Siebel, Vantive) to provide some powerful holistic functionalities including:

- Customer database for knowing and understanding customer characteristics.
- Managing the relationship with key business partners, (e.g. customers).
- Providing value added services to retain customer loyalty.
- Transparency and real-time acceptability of information for both customers and suppliers.
- Optimizing cross-selling opportunities.

SCM solutions

The emerging dot.com companies may be ‘fireflies before the storm’ (Lou Gerstner, IBM), but most companies now recognize that the Internet has a profound effect on supply chain performance. The key issues of e-supply chain have been covered in more detail in Chapter 13. Applications that fall into this category are essentially decision support software packages for optimizing multiple levels of demands and supply in the global supply chain.

A new area of CPFR (Collaborative Planning Forecasting and Replenishment) for key stakeholders of the total supply chain has emerged. As we discussed in Chapter 12 (also see Chapter 14), in CPFR data and process model standards are developed for collaboration between suppliers and an enterprise with proscribed methods for planning (agreement between the trading partners to conduct business in a certain way); forecasting (agreed to methods, technology and timing for sales, promotions, and order forecasting); and replenishment (order generation and order fulfilment). These solutions take into account the constraints of transportation, supply capacity and inventory requirements. The ultimate objective is order fulfilment within the time and cost acceptable to customers.

The leading vendors' niche in the market, (e.g. i2 and Manugistics), is being challenged by ERP vendors such as SAP, Oracle and J D Edwards.

EAI and middleware

The benefits of using an e-business solution increase in direct proportion to the degree of integration between the customer and the marketplace. It is impractical to make any attempt to change the software and platform of the acquired customer to those of the acquirer. Therefore, the effectiveness of handling real-time transactions in an e-business environment will depend on the technology 'building blocks' enabling the integration and interfaces of all parameters.

The key set of 'building blocks' are EAI and middleware applications that bring together the information the exchange needs from disparate internal systems. This is often referred to as 'back-end integration' and can account for up to 75 per cent of the costs of going on-line.

Application service providers

'An ASP is an agent or broker who assembles functionality needed by enterprises or SMEs and packages it with outsourced maintenance and other services' (Durlacher, 1999).

The growth of ASP solutions started with packaged services provided by e-commerce application software vendors (e.g. Ariba, Commerce One, Broadvision). The penetration of the market came from the ASP's ability to take responsibility for system development and maintenance while avoiding the overhead of expensive IT staff. This means that smaller firms are being offered fully managed and large organizations are receiving part-managed ASP services.

Technology platforms

Technology platforms are supported by two groups of vendors. Hardware technology is provided by established computer companies (viz. IBM, HP, Compaq and SUN). The other group supporting network technology comprises the telecommunication operators (e.g. BT, MCI, France Telecon, Deutsche Telecom, AT&T) and infrastructure companies (e.g. CISCO, EXODUS).

Technology companies are forming strong partnerships or alliances to provide end-to-end technology solutions especially to SMEs. Examples include the partnership deals between Compaq and Cable and Wireless as well as SUN's alliance with Oracle.

Protocol and security

Protocol and security are the key building blocks of data transmissions and data security. The Internet uses a special language or protocol to ensure safe arrival of data at its intended destination. This language has two parts:

1. TCP (Transmission Control Protocol)
2. IP (Internet Protocol)

TCP divides the data into small 'packets' adding information that allows the receiving computer to assure undamaged transmission. IP puts end 'address labels' on each packet. HTML or Hyper Text Markup Language is the TCP and XML or eXtensible Markup Language allows the dynamic logging of text in documents. This enables internal systems at the customer and the marketplace to send machine readable messages to each other. XML is hailed as the 'lingua franca' for data transfer in the cyber realm. The flexible formats of XML offer a transition from EDI fixed formats to self-identifying data.

System integrators

The final piece of the e-business 'building block' is the art and science of pulling together all elements of an e-business project and making it work. The lower end of the market for SMEs and startup companies has been addressed by ASPs working together with hardware vendors (IBM, HP, Compaq) and software vendors (Microsoft).

However in a multi-functional, multi-site large application business it is necessary to redesign the way they work in terms of both processes and culture in order to gain sustainable benefits from e-business. This requires not only the integration of IT systems between businesses but also process improvement and continuous education. There is a large gap between software functionality and the existing business process. Furthermore, the number of users in an e-business project is many times more than those expert users of an ERP application. Thus the challenge on the shift of culture is much greater in implementing the business.

Summary

This chapter has covered quality management, financial management and IT. We are not suggesting that we have written a complete accounting text book or the definitive work on IT. Far from it.

With quality management we have however gone into greater depth. Quality management is not a discipline restricted to one body of knowledge or expertise. Quality management is for everyone in the company to know and to understand in detail.

We have shown quality management has three dimensions – design quality, process quality and organization quality. Furthermore quality is basically what customer wants and it operates at two levels – basic requirements of specification, time and cost, and higher level requirements covering after delivery service and customer focus issues. We accept quality has a price but the cost of not performing can be unknown and is probably unknowable.

We also discussed a hierarchy of quality methods ranging from inspection at the end of the process, to no inspection by supervisors and the reliance on suppliers, and each worker in the process to get it right first time, every time. For such a bold approach to be viable – for example no supervisors, no inspectors – workers must be empowered. But more than that, they must want to be empowered, and managers must believe and trust. For most companies this is a desirable goal but probably not something to be attempted overnight!

We also covered ISO certification. We believe that many people see ISO as a goal in itself. We say ISO certification may be a step on the way to TQM but it is only a small and expensive step. We suggest that a true TQM company does not need certification.

With financial management we introduce key concepts and ratios. Unless the factory manager understands these ratios he or she will always be at the mercy of the accountants. The ratios are explained simply, and illustrated with easily understood examples. If you have some accounting knowledge, do not skip this section, take 5 minutes to work through the examples and consider how they apply to your organization.

Some time is spent on ROI and some time on cost cutting. Both these areas are of particular concern to the factory manager. ROI can be used to prevent you getting much needed equipment. Cost cutting, if applied 5 per cent across the board, will inevitably hit the factory the hardest. Other sections probably do have some slack or spare capacity but does your factory? It is important that the factory manager understands ROI and that the factory manager can defend him or herself against ill judged cost cutting exercises.

For IT we have taken a more general approach. This section is equally applicable to all functions of the organization. The key issue in any new IT system is knowing what you want, going with a system with local support, and initially making do with off-the-shelf software. We have not discussed uninterrupted power supply, disaster recovery, the need to back-up files and so on. All these issues are nuts and bolts and should be second nature to your IT manager. This section was not written for the professional IT manager. It was written to give the average manager an understanding of the strategy of IT implementation. We have also addressed the opportunities and challenges emerging from e-business technologies and powerful software solutions such as SAP R/3, i2 and Siebel. We have also discussed the shift of hardware platform from mainframe to client/server platforms and the conflict in the software strategy between ‘best of breed’ versus ‘single integrator’.

During the last 10 years we have experienced the growth of e-business applications and enabling infrastructures that have rapidly increased productivity by streamlining existing business processes. We have also seen over the last few years some dramatic failures of pure play e-commerce companies.

The time has come to take a fresh look of the Internet technology. We need to move away from the rhetoric of 'dotcom revolution' and to see the Internet as a powerful enabling technology that can be used in almost any business and part of almost any strategy. The key question now not whether to deploy the Internet technology, but how to deploy it.

With a good understanding of the scope the systems and procedures discussed in this chapter supply chain managers should be better equipped to integrate the building blocks of supply chain to provide, improve and sustain supply chain performance.

18

Sales and operations planning

Introduction

Alongside Systems and Procedures (Chapter 17) and Performance Management (Chapter 19) sales and operations planning (S&OP) is an integrator of the building blocks of total supply chain management. Systems and Procedures provide the tools, Performance Management offers the metrics and S&OP delivers the processes to make it happen. With S&OP the general manager and his or her staff can operate their supply chain more effectively, set attainable objectives with a single set of data for all departments, communicate approved S&OP over a planning horizon, measure performance and achieve target results. The data from the business plan is converted into sales, inventory and production plans with formal discussions and agreement of each departments at appropriate stages. All key managers and staff are involved in the process but not at the same meeting. Thus, S&OP provides both effective control over company's operation spanning all the building blocks of total supply chain and acceptance of staff in all departments. S&OP and its hybrids are also known by other names in different organizations, such as Sales Inventory and Operations Planning (SIOP), Senior Management Reviews (SMR), Integrated Business Management (IBM) and Collaborative Planning Forecasting and Replenishment (CPFR).

In this chapter, we cover the characteristics, applications and benefits of S&OP under the following headings:

- Background to S&OP
- Definition
- Key steps of S&OP
- S&OP in service organizations
- Collaborative planning forecasting and replenishment
- Shift in performance criteria
- Benefits of S&OP

Background to S&OP

The classical concept of S&OP is rooted to the MRPII (manufacturing resource planning) process. In the basic S&OP, the company operating plan (comprising sales forecast, production plan, inventory plan and shipments) is updated on a regular monthly basis by the senior management of a manufacturing organization. The virtues, application and training of the S&OP have been promoted by Oliver Wight Associates (see Ling and Goddard, 1988) since the early 1970s.

Every organization usually has some form of regular planning meeting in which the financial and business plans are reviewed and often some marketing and operational targets are discussed by a group of managers. These monthly meetings tend to deal with short-term problems and opportunities and usually decisions are made by the subjective judgments of an influential senior manager. In many companies, what passes for S&OP is often little more than a monthly review of the performance of the master production schedule. Many software providers also take the view that it is best done as an extension of the existing product level planning process. In our experience, both of these approaches fail to achieve the very real business benefits that an effective S&OP process can deliver. S&OP should be treated as a formal planning and execution process and not as a set of planning meetings. Whether the business processes are forecast driven MRPII processes or order driven pull or just-in-time (JIT) processes the role of S&OP are equally important. Furthermore, there must be a process within S&OP that breaks down the aggregate plan into detailed plans.

In recent years the pace of change in technology and marketplace dynamics have been so rapid that the traditional methodology of monitoring the actual performance against per-determined budgets set at the beginning of the year may no longer be valid. It is fundamental that businesses are managed on current conditions and up-to-date assumptions. There is also a vital need to establish an effective communication link, both horizontally across functional divisions and vertically across the management hierarchy to share common data and decision processes. Thus, S&OP has moved beyond the operations planning at the aggregate level to a multi-functional SMR process.

For the S&OP process to work, the decision-making group, usually the Executive Board, need to be provided with quantitative information as well as qualitative information over a planning horizon of around 2 years. Moreover, if the purpose is to find the best option, or indeed the least worst, the decision-making group need to be presented with alternatives that explore the relative costs, benefits and risks of different courses of action. The future is harder to predict for the medium term than the immediate short-term future. Irrespective of medium or short term, forecasting is as much an art as a science and it is usually necessary to explore several possible scenarios, assigning to each a degree of risk and probability.

Definition

The traditional S&OP is an SMR process of establishing the operational plan and other key activities of the business to best satisfy the current levels of sales forecasts according to the delivery capacity of the business.

Ling and Goddard (1988) summarize a ‘capsule description of the process’:

> *It starts with the sales and marketing departments comparing actual demand to the sales plan, assessing the marketplace potential and projecting future demand. The updated demand plan is then communicated to the manufacturing, engineering and finance departments, which offer to support it. Any difficulties in supporting the sales plan are worked out … with a formal meeting chaired by the general manager.*

Dick Ling, almost the founding father of S&OP defines sales and operations planning as a process, rather than a system, says it is ‘The process that enables a company to integrate its planning within the total company’. The outcome of the process is the updated operation plan over 18 months or 2 years (the ‘planning horizon’) with a firm commitment for at least 1 month.

The process is data driven. A report for each product family is prepared for the planning horizon and it is usually divided into up to five sections containing ‘a single set of numbers’ for Sales Plan, Production Plan, Inventory, Backlog and Shipment.

Key steps in S&OP in manufacturing organizations

In developing the key steps of the S&OP process two key challenges should be addressed at the outset. They are the simplification of the process and the accuracy of demand forecasts.

Simplification

Most businesses are complex and generate a mass of data at the operational level in terms of the number of SKUs (stock keeping units), materials and resources used. For example, the Financial Manager wants the numbers in dollars, the Marketing Manager expects numbers in SKUs, the Manufacturing Manager like to plan by tonnage while the Logistics Manager prefers the numbers to be in terms of cases or pallets. A model that attempts to flex each one of these becomes too unwieldy. Projecting out 2 or more years at this level of detail for each unit is not a problem for the computer; we now have access to more than enough computing power to do this. The difficulty is in analysing, understanding and evaluating the mass of output that such an approach generates. Companies that have tried doing it this way have found it virtually impossible to interpret the results. Therefore, we need a single set of numbers understandable and usable by all departments of the supply chain.

Forecast accuracy

The nature of the S&OP means that it needs a planning horizon that stretches well beyond the MPS (master production scheduling), usually between 18 months and 2 years but sometimes more depending on the nature of the business. Because of the rate at which forecast accuracy deteriorates with time, any forecast produced at the SKU level becomes unusable as the accuracy is simply too low to be of any use.

These potential problems are overcome by:

- Grouping demand together into families, so that aggregating the variations in each homogeneous family reduces the forecast error.
- Identifying the small number of critical resources, whether labour, equipment, material or plant that must be dealt with separately.
- Selecting a single unit of data for demand, production and inventory with acceptable conversion factor to help interpretation by respective departments.

S&OP has become an established company-wide business planning process in the Oliver Wight MRPII methodology (Wallace, 1990). To understand the key steps of S&OP in a manufacturing organization it is also important to understand MRPII methodology.

Materials requirement planning (MRP) is the set of techniques which uses bills of material, inventory on hand and on order data, and the production schedule or plan to calculate quantities and timing of materials. Such a plan is incomplete if it does not take into account whether manufacturing resources (e.g. plant, people, energy, space) will be available at the desired time. MRPII arose from an appreciation of the need to time and phase materials with resource availability so as to achieve a given output date. MRPII is an integrated computer-based system. A computer-based approach is essential due to the amount of data required. Various software systems are available, each based on the same principles. MRPII is depicted in Figure 18.1.

With MRPII the planning process arises from the innovation of new products and the strategic marketing plan. Starting with this information a business plan is constructed to determine and communicate estimates of the sales volume of each product range. The business plan should be developed at least once a year and during the year periodic updates will be required.

From the business plan, an operations plan is formulated which covers the materials and other resources needed to translate the business plan into reality. It follows that to keep the operations plan in line with updates to the business plan, regular communication is required between the various functions involved. This updating process is best achieved by face-to-face meetings which we recommend should take place at least once a month and always with all parties present at one time. There is a very real danger of misunderstandings and ambiguities if meetings are not face-to-face and if all concerned are not present at the same time. Meetings need not be long drawn out affairs. From experience we believe that any planning meeting that takes longer than an hour is wasting time. The key managers at these meetings will be from sales, operations and planning. The issues that will be agreed will include time and availability of resources, and conflicting requirements and priorities will be resolved.

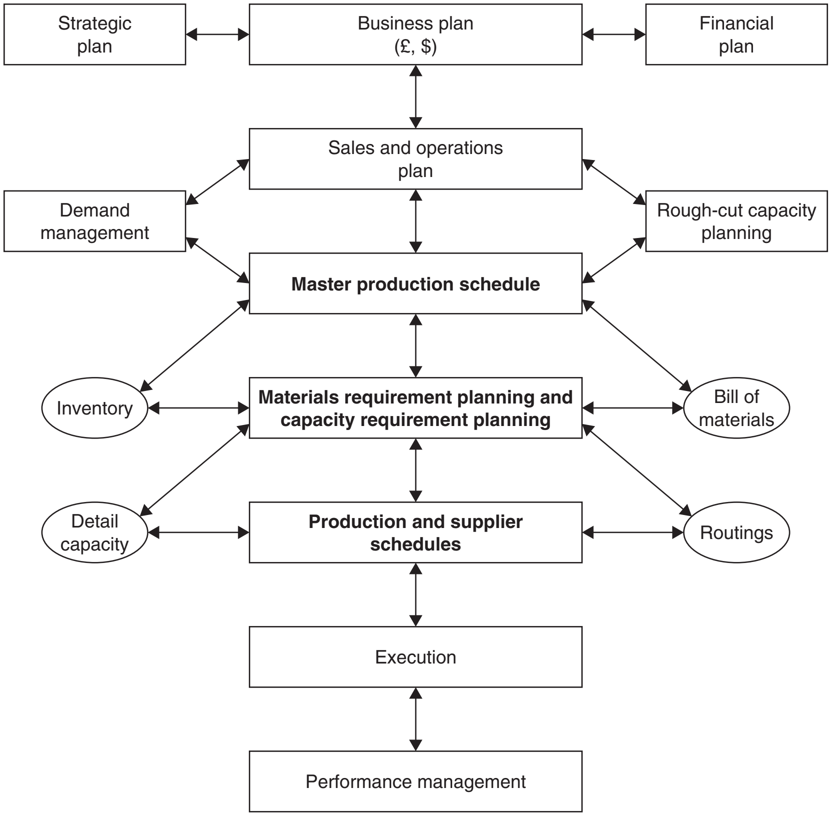

Figure 18.1 Manufacturing resource planning.

Above all demand is the crucial issue, and as future demand can never be certain there should be a formal mechanism of forecasting using the best combination of historical models, past results from promotions, data from customers and market intelligence. Likewise, the inventory data system has to be up-to-date and accurate with details of raw materials (RW) on hand, goods on order, lead times and finished goods on hand.

Only with up-to-date information, and with the continuous review and management of information, can an organization hope to achieve a balance of resources and stocks of inventory to meet planned service levels. The master planning and production scheduling process therefore has to be continuously monitored and updated to ensure that this occurs.

The master production plan or master schedule is at the heart of MRP where both the timing and quantity of orders are determined from offsetting from the current stock the demand during the lead time to meet the master production plan.

The next stage is to follow a rough-cut capacity planning process to assess to what extent the capacity of manufacturing facilities could meet the master schedule. The feedback loop at this level tests the master plan against problem areas such as known bottlenecks and other critical resource areas. Often, as this is a short- to medium-term approach, action has to be taken to make the best use of existing resources rather than to add extra long-term resources. The company should decide which alternative to follow if the existing resources are not adequate, for example review the schedule, increase resources, work extra shifts, delay maintenance, outsource to third parties and so on. With computer systems it is relatively straightforward to simulate using 'what if' scenarios to evaluate alternative courses of action.

Having established that the resources are sufficient, or having adjusted the plan to fit the resources, then the next step is the detailed MRP and the detailed capacity requirements planning for day-to-day operations. This stage includes the production of detailed bills of materials for each product or batch of products. With the revised master schedule for each product and for each SKU and bills of material for each SKU, the materials required for each item of raw materials (RM) and packaging materials (PM) are then matched with the current inventory levels to derive the additional procurement requirements. The requirements are modified, if required, after comparing with the detailed capacity planning process. The execution of the planning process then commences with the final production scheduling and purchasing (supply planning) processes.

We have outlined a generic description of the MRPII process. There are of course variations – more significantly between batch production processes and continuous production processes and between so called 'push' or 'pull' demand systems. With the 'push' system stocks of materials and of finished goods are used to ensure maximum plant capacity utilization by having level production. The 'pull' system is driven by customer orders and JIT principles which can result in some under utilization of capacity. It is said that JIT requires greater flexibility and reliability of plant plus a multi-skilled workforce. In its simplistic form JIT is reactive (demand pull), whereas MRPII can be described as proactive. MRPII looks forward and determines what will be needed to achieve a desired output date. Internally MRPII is a push system; inventory is driven through the process by the schedule. Thus, customer requirements are linked to the resources and materials necessary so as to precisely meet a JIT delivery date. From a customer's point of view it could be argued that as long as the goods arrive on time and meet the specifications, the system used by the manufacturer is irrelevant!

The process has been developed and applied primarily for manufacturing organizations. The key members of all departments, such as R&D, Marketing, Sales, Logistics, Purchasing, Human Resources, Finance and Production, participate in the process but not at the same meeting. S&OP addresses the operations plan that deals with Sales, Production, Inventory and Backlog and thus it is expressed in units of measurements such as tonnes, pieces, etc. rather than dollars or euros. The operation plan is reconciled with the business plans or budgets which are expressed in terms of money.

The S&OP or Senior Management Review process has been proven to be a key contributor to sustaining the performance level achieved through a TQM or

Six Sigma programme (Basu and Wright, 2003, p. 97). The S&OP agenda, in addition to its main focus of establishing the operation plan, contains the reviews related to performance and key initiatives. This provides an effective platform for senior managers of all functions to assess the current performance and steer the future direction of the business.

Key steps

With the above backdrop we can now describe the key steps of the S&OP process.

Figure 18.2 shows the five steps in the S&OP process that will usually be present and this process can be adapted to a specific organization requirement:

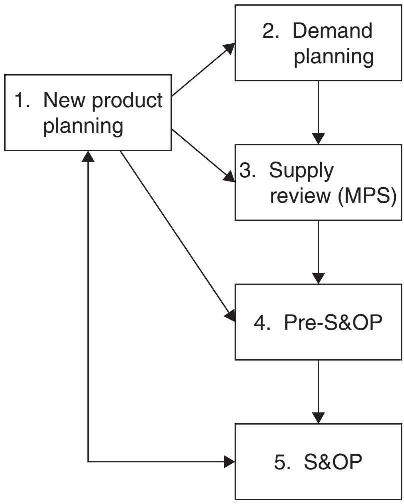

Figure 18.2 Five steps of S&OP process.

- *New product review (Step 1)*: Many companies follow parallel projects related to the new products in R&D, Marketing and Operations. The purpose of this review process in Step 1 is to review the different objectives of various departments at the beginning of the month and resolve new product related assumptions and issues. The issues raised will impact upon the demand plan and the supply chain at a later stage of the process.
- *Demand review (Step 2)*: Demand planning is more of a consensus art than a forecasting science. Demand may change from month to month depending on market intelligence, customer confidence, exchange rates, promotions, product availability and many other internal and external factors. This review at the end of the first week of the month, between Marketing, Sales, IT and Logistics, establishes agreement and accountability for the latest demand plan identifying changes and issues arising.

- *Supply review* (*Step 3*): In the current climate of increasing outsourcing and supply partnership, the capacity of supply is highly variable and there is a need to ensure the availability and optimization of supply every month. This review, usually on the second week of the month, between Logistics, Purchasing and Production, establishes production and procurement plans and raises capacity, inventory and scheduling issues.
- *Reconciliation review* (*Step 4*): Issues would have been identified in previous reviews of new products, demand and supply. The reconciliation step goes beyond the balancing of numbers to assess the business advantage and risk for each area of conflict. This review looks at issues from the business point of view rather than departmental objectives. This is also known as the pre-S&OP Review and its aim is to minimize issues for the final S&OP stage.
- *Senior management review* (*Step 5*): Senior Mangers or Board Members, with an MD or CEO in Chair, will approve the plan that will provide clear visibility for a single set of members driving the total business forward. The agenda (see Table 18.1) includes the review of key performance indicators, business trends of operational and financial performance, issues arising from previous reviews and corporate initiatives. This is a powerful forum to adjust business direction and priorities. This is also known as the S&OP review.

In each process step the reviews must address a planning horizon of 18–24 months in order to make a decision for both operational and strategic objectives. As shown in the example below the demand forecasts of product groups

Table 18.1 An agenda for S&OP meeting

Performance review	*20% of meeting time*
• Customer Service	
• Actual sales versus plan	
• Actual production versus plan	
• Actual inventory versus plan	
• Financial performance	
• Critical root cause analysis	
• Balanced Scorecard (selected key performance indicators (KPIs))	
Forward plan	*80% of meeting time*
• Sales plan	
• New product introduction	
• Production plan	
• Inventory plan	
• Backlog and backorders	
• Pre-S&OP issues	
• Financial projections	

are reconciled with respective inventory projections to establish the master production schedule over the planning horizon. There may be a perceived view that S&OP is a process of aggregate/volume planning for supply chain. However, it is also a top level forum to provide a link between business plan and strategy. It is emphasized that that even though these five steps are usually executed in the order presented above, it is best to view S&OP as an iterative process, since a well executed S&OP process leads to iterative improvements over time.

Example: Sales and operations planning

Table 18.2 shows a worked-out example of a product pack: Aquatic 500 in the unit of packs. The report is divided into four sections:

1. Sales
2. Stock
3. QA release
4. Production

In addition it contains some useful data, such as production batch size (180), lead time (2 months) and stock target (3 months). The columns to the left of the line 'Today' show historical data and to the right is the information for the planning horizon in the future.

The data for the sales budget are taken from the annual business plan. 'Latest Forecast' represents what the sales and marketing teams are projecting based on the latest information. This data is updated every month. The stock target for each month is based on the sales forecast for the next 3 months, as the target is 3 months' stock cover. Due to a technical problem, production was suspended for 6 months and is resumed from this month. Therefore, a backlog of order or negative stock (-1194) has been built up in the current month.

The projected stock is calculated by using the formula:

$$\text{Stock this month} = \text{Stock last months} - \text{Sales} + \text{Delivery}$$

For example, the projected stock for October $= -2094 - 500 + 3600 = 1006$.

It is important to note that planned production should be in multiples of the batch size, that is 180 and the volume is available after 2 months' lead time.

(*Text continued on page 330*)

Table 18.2 S&OP forecast of Aquatic 500

Product: Toothpaste

Unit: Packs   Supply Source:

Pack: Aquatic 500

Shelf Life: 3 years

Prodn Batch Size: 180
Prodn + QA Lead Time: 2 Months
Stock Target: 3 Months

Month	**−6 Feb**	**−5 Mar**	**−4 Apr**	**−3 May**	**−2 Jun**	**−1 Jul**	**1 Aug**	**2 Sep**	**3 Oct**	**4 Nov**	**5 Dec**	**6 Jan**	**7 Feb**	**8 Mar**	**9 Apr**	**10 May**	**11 Jun**	**12 Jul**
SALES																		
Budget	500	500	500	525	600	600	600	550	550	525	525	525	525	525	525			
Latest Forecast	500	400	450	400	500	400	500	400	500	400	500	500	500	500	500			
Actual																		
STOCK																		
Target	1250	1350	1300	1400	1300	1400	1300	1400	1400	1500	1500	1500	1000	500	0			
Projected	956	556	106	−294	−794	−1194	−1694	−2094	1006	606	1906	1406	1806	1306	806			
Actual																		
QA RELEASE																		
Planned	0	0	0	0	0	0	0	0	3600	0	1800	0	900	0	0			
Actual																		
PRODUCTION START																		
Planned	0	0	0	0	0	0	3600	0	1800	0	900	0	0	0	0			
Actual																		

Year to Date: **Sales Budget:** 3225 **Actual Sales:** **Forecast Performance**
Sales Forecast: 2650 **Stock Performance**

A key feature of S&OP emerging from the above five steps is that S&OP is not only a driver in a MRPII system, it acts as an integrator of all building blocks of supply chain and all functional departments of the organization. As shown in Figure 18.3, S&OP spans across all departments and key departmental plans at the aggregate level are embedded in S&OP. An updated aggregate new product plan is reconciled with the total sales demand plan. These are then communicated by appropriate review meetings to manufacturing and finance departments, which offer ways to support it by reconciling them with aggregate finance plan and supply plan.

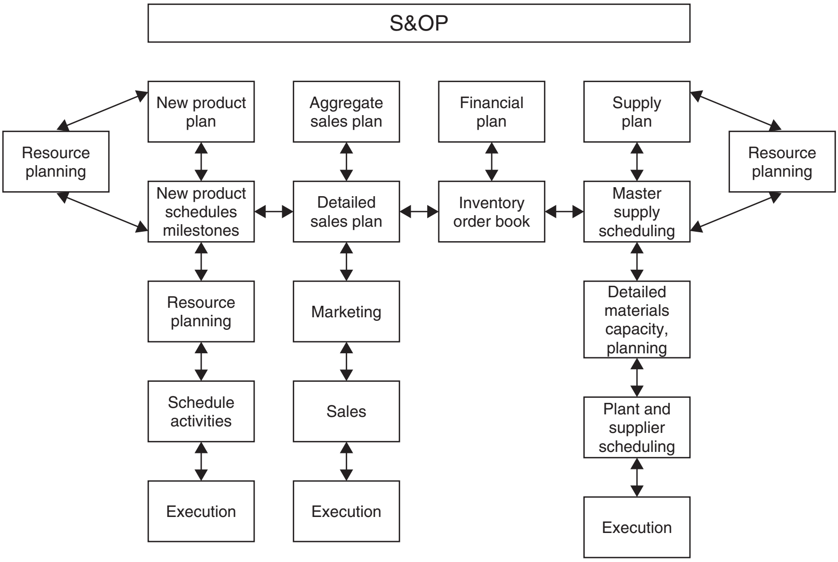

Figure 18.3 Span of S&OP.

It is also important to note that meetings of five key steps (viz. new product planning, demand planning, supply review, pre-S&OP and S&OP) support the MRPII processes as shown in Figure 18.4. For example, demand management process is supported by new product planning meeting and demand planning meeting. Supply review meeting supports and establishes MPS and subsidiary manufacturing processes are supported by weekly and daily meetings.

As shown in Figure 18.5, the key S&OP meetings in five steps are conducted each month in successive weeks and are supported by other important business meetings on annual, quarterly, weekly and daily schedules. The visibility of these meetings must not be construed as an indication of 'too many meetings' of talking shops. On the contrary these are aimed at cascading the communication process across the organization to arrive at rapid decisions based on quantitative data understandable and usable by all stakeholders.

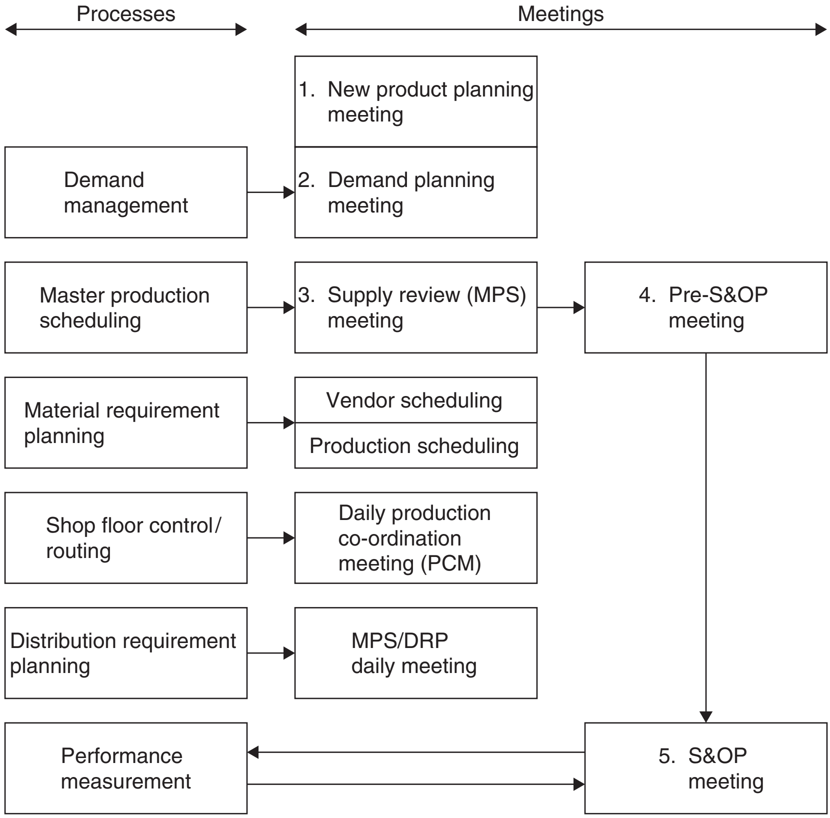

Figure 18.4 S&OP processes and meetings.

Annual
Strategic review

Quarterly
Business review

Monthly

New product planning meeting	1st week
Demand planning meeting	1st week
Supply review (MPS) meeting	2nd week
Pre-S&OP meeting	3rd week
S&OP Meeting	4th week

Weekly
Vendor scheduling
Production scheduling

Daily
Production co-ordination meeting
MPS/DRP meeting

Figure 18.5 S&OP planning cycles and meetings.

Case example: S&OP ensures sustainable performance at GSK Turkey

GlaxoSmithKline Turkey (GSK Turkey, previously known as GlaxoWellcome Turkey) was awarded MRPII 'Class A' certification in 1999 by business education consultants Oliver Wight Europe.

GSK Turkey launched a programme (known as EKIP) in January 1998 to improve company-wide communications and sustain a robust business planning process using MRPII 'best practice' principles.

Since September 1998, the company has improved and sustained a customer service level at 97 per cent and inventory turnover of around 5.0. The sales turnover in 1998 has increased by 20 per cent in real terms in spite of some supply shortfall from the corporate network in the first half and the adverse economic and political conditions of Turkey. GSK Turkey has been recognized as a major business in the pharmaceutical giant GSK Group and the business plan for 1999 was aiming at a turnover of US $110 million.

As part of the MRPII Class A programme, GSK Turkey installed an S&OP process which is underpinned by a set of business planning meetings at various levels. In spite of the GW and SB merger and the corporate Lean Sigma initiative, the S&OP process has been continued by the company every month.

The vigour of the S&OP process which is championed by the Managing Director has helped the company to sustain and improve the business benefits and communication culture especially when they were challenged by a number of initiatives in hand, including:

- Transfer of office
- Rationalization of factory and warehouse
- Corporate Lean Sigma programme
- Merger of GlaxoWellcome and SmithKline Beecham

Source: Basu and Wright (2003)

S&OP programmes have saved manufacturing companies millions in supply chain costs and improved inter-departmental co-ordinations with no loss to customer service. A recent report by Booz Allen Hamilton (2006) quoted the following examples of improvements by S&OP:

- A global commodity manufacturer saved $120 million from operational improvement initiatives and reduced inventory by $100 million, largely as a result of S&OP work.
- A North American durable goods manufacturer reduced its inventories by 30 per cent saving $300 million.

- An European cosmetics manufacturer reduced its working capital needs by more than 15 per cent, while improving its promotion planning.

S&OP in service organizations

With appropriate adjustments for the units of the products, the S&OP process can also be applied to service industries. This will encourage the managers in non-manufacturing sectors to review the demand, capacity, inventory and scheduling, and enhance the synergy of different functions.

Many service organizations already have existing processes that are designed to support the medium- to longer-term decision-making activities that are required to turn the long-term business plan into reality. In many cases, these revolve around the capital spend authorization process, the associated justifications and approvals, and the subsequent development and implementation of specific projects.

In many cases these work well, but it reflects a situation where the integration between the business plan, the operational plan and the projects that will deliver future capability is at best informal. Mostly it resides in the minds of the main players, the executive team. A service organization, such a bank or insurance company should have a distinct marketing and sales function and an operation function. Service companies without a formal S&OP process are experiencing a lack of integration, between marketing and operations, particularly in terms of timing and customer demand. This has adversely affected their ability to meet increasing customer demand in the operational horizon.

S&OP, properly established, provides a level of integration between the short-term operational plans and the long-term business plans that helps to address this problem. It is not a complete solution in that it allows the uncertainty to be explored; it cannot be removed. But at least it informs the decision-making process and allows alternative courses of action to be compared.

There are five major factors why companies undertake an S&OP process supported by an enterprise resource planning (ERP) system:

1. Integrate financial information
2. Integrate customer order information and demand plan
3. Standardize and speed up supply processes
4. Reduce inventory
5. Standardize HR information

It is true that ERP is basically a second-generation MRPII system which is predominantly in manufacturing organizations. However, if we consider the above five reasons from the standpoint of a service organization we see that all factors, arguably with the exception of ‘reduce inventory’ are applicable to justify an ERP system. More importantly if you consider the ERP process rather than the software it is evident that the interaction between all functions with a ‘single set of numbers’ is equally important for an effective service enterprise.

The second and third factor of applying ERP relate to resource planning. Every service company has customers, demands, in-house resources and suppliers and therefore requires resource planning to deliver an effective customer service. We call this operations resource planning (ORP) as illustrated in Figure 18.6.

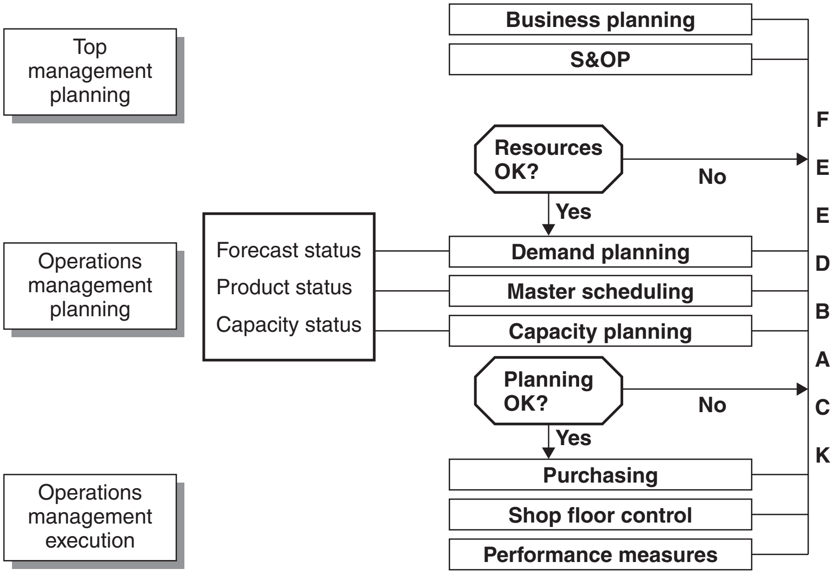

Figure 18.6 Operations resource planning.

It is evident from Figure 18.6 that although ORP is not as detailed as MRPII the key steps of the process are similar. From the business plan, an S&OP which covers key products and resources needed to deliver the business plan. The monthly S&OP meeting by senior managers approves the master operations plan. The operations team will review the product portfolio, supplier status and the capacity of own resources and ensure that purchase orders are raised to procure appropriate resources or services from suppliers. If the capacity of own resources are adequate then an internal control document for the customer order is processed. But a partnership with customers and with suppliers can and will achieve very obvious benefits to all. As a result of such a radical change, each of the service provider, the supplier and the customer achieve benefits in:

- lower operating cost,
- improved service level,
- a greater certainty of a continued relationship.

The boundaries between companies will blur as they view themselves as part of an ecosystem, supply chain, or value chain.

Hasso Platner, co-founder and vice chairman, SAP

Case example: S&OP in financial services

The S&OP principles were turned into practice for the securities division of a diversified financial services company that operates in more than 40 locations worldwide. This division was serving brokerage clients employing about 3000 staff performing more than 600,000 transactions per month.

Before management started using some of the S&OP principles the service philosophy of their operations department appeared to be 'Give everything to everybody, as best as we can'. In line with this unspoken philosophy, a sprawling system had developed as operations tried to serve a variety of different customers with no regard for their individual needs. Further complicating the issue was poor co-ordination between the sales force in the field and the operations teams in parts of the business. The result was wildly inefficient, with services delivered in ways that turned out to be several times more expensive than necessary.

To create a more sustained operation, management adopted the key S&OP principles particularly applicable to their business including:

- Set service and supply policies (e.g. what should be the maximum time that a customer is allowed to queue).
- Tighten forecasts by regularly reviewing that factors that drive demand volatility (e.g. promotion and pricing) and using forecast tools.
- Use analytical models to guide executives in balancing the trade offs between resources and customer service.
- Communicate across functions by formal review meetings.
- Track key metrics (e.g. agent utilization, number of processing errors, etc.).

The results were significant. Costs decreased by 15 per cent. Processes and services were also changed dramatically, not only in terms of efficiency (e.g. lead times) but also in terms of effectiveness. While it took to open new accounts was reduced by up to 60 per cent, document reject rates also improved from 30 to 10 per cent, and accuracy of response improved across all channels by over 10 per cent.

Source: Booz Allen Hamilton (2006)

Collaborative planning forecasting and replenishment

CPFR is the latest in a series of concepts and initiatives that have emerged, developed, evolved and sometimes died in the name of a 'new concept' of supply chain management. A number of programs and methods make up the current replenishment soup that has existed in industry over the past two decades including manufacturing resources planning (MRPII), enterprise resource planning (ERP), efficient consumer response (ECR), just-in-time (JIT), vendor managed inventory (VMI), distribution resources planning (DRP) and finally jointly managed inventory (JMI) to name a few. CPFR falls into the last category as it truly is a well-developed and tested method of jointly managing inventory and replenishment throughout the supply chain process.

CPFR is often closely associated with e-supply chain (also see Chapter 13) in which CPFR process is supported by an ERP system (such as SAP R/3) and electronic linking of customer and supplier data using Internet technologies. The support of technology enables the adoption of collaborative planning and scheduling with critical suppliers and customers allowing effective sharing of forecasts and order status. The real time access to data has enabled trading partners to have visibility into one another's critical demand, order forecasts and promotional forecasts through a systematic process of shared brand and category plans. This sharing is enabled by technology by the review of exceptions and resolution of issues can only be effective when CPFR is embedded into the S&OP process. The S&OP meetings of the original equipment manufacturer (OEM) should include key suppliers and business partners linked virtually through a teleconference or video conference network. Under CPFR in its pure form both trading partners develop a joint business plan for the specific product group which also includes a promotion calendar. The retailer and manufacturer also agree on a joint sales forecast. The joint sales forecast can drive production scheduling and distribution planning. Any changes from any of these forecasts are defined as exceptions. These exceptions will generate collaborative actions in joint S&OP meetings to re-align planning for the channel.

The origin of CPFR is attributed to a working group formed in 1995 between Wal-Mart stores and Warner-Lambert Company to pilot test a new model for collaboration on the forecasting and replenishment of Listerine in stores. There have been many reports on the benefits of CPFR. After 7 years a study by the Grocery Manufacturers of America (GMA) (2002) showed that the two-thirds of the survey correspondents said some CPFR activities are in place at some level in their companies. The survey also reported that among the experienced users of CPFR, 67 per cent achieved 1–10 per cent improvement in forecast accuracy and 56 per cent reported a decrease in inventory and improvement of service levels by up to 10 per cent. While most GMA member companies entered CPFR partnerships with downstream wholesalers and retailers, only 6 per cent of companies were piloting with an upstream partner (such as suppliers of production materials, warehouse space, etc.). AMR Research (2001) reported on the range of results actually achieved by early adopters of CPFR, which included 10–40 per cent reduction of inventory levels for both the manufacturer and retailer.

Case example: CPFR in Whirlpool

> *Five years ago, sales people at Whirlpool said the company's supply chain staff were 'sales disablers'. Now, Whirlpool excels at getting the right product to the right place at the right time – while keeping inventory low. What made the difference?*
>
> VP Global Supply Chain, Whirlpool 2004

One of the key factors in the turnaround of Whirlpool's supply chain was the roll out of a new S&OP process. Whirlpool Corporation is a global manufacturer and marketer of major home appliances, with annual sales of over $13 billion, 68,000 employees, and nearly 50 manufacturing and technology research centres around the globe. With the head office based in Michigan the company markets Whirlpool, KitchenAid, Brastemp, Bauknecht, Consul and other major brand names to consumers in more than 170 countries.

The old planning environment of Whirlpool was inadequate and planning tools did not go far beyond Excel spreadsheets. With the introduction of the S&OP process, the company now has the ability to pull together the long- and short-term plans of marketing, sales, finance, logistics and manufacturing and produce forecasts that all participants could base their operation plans on.

The next step of Whirlpool was to push their forecasting capability in the global supply chain further by implementing CPFR process. With CPFR the company can use i2 software supported by a web-based network to share their forecasts with trading partners (such as Wal-Mart and Sears) and collaborate on the exceptions. Within 30 days of the launch of CPFR the forecast accuracy error was cut from 100 to 45 per cent. To put in perspective, a one-point improvement in forecast accuracy across the board reduced the total finished goods position of the company by several million dollars.

Adapted from Slone (2004)

Shift in performance criteria

A little more than a decade ago companies were urged to attain so-called 'world class' performance within the enterprise. The departments within companies were striving for islands of excellence and then with a succession of operational excellence initiatives (e.g. TQM, BPR, MRPII and Six Sigma) the 'walls' between departments were gradually demolished. Organizations started to become customer focused with established performance metrics in all areas of the business (e.g. 'Balanced Scorecard'). However, it is fair to say that both the business model and the performance metrics were site-centric or at best confined within the company or enterprise. Although the need for externally focused performance metrics from the perspective of a customer or an external supplier was identified unfortunately in most companies metrics were not identified, or if identified not implemented beyond mere lip service.

With web-based technologies now accelerating it is becoming imperative to rethink the selection and implementation of the external metrics. This shift is not only in the measurement criteria but also in the mind-set of business practices. Collaboration requires a capacity to 'work in association, sometimes, with an enemy' and does not achieve its business success at the competitor's expense. Table 18.3, adapted from Basu (2001), summarizes some specific areas where performance criteria have shifted along with changes from the enterprise-centric business to a collaborative supply chain.

Table 18.3 Shift in performance criteria

Enterprise	Integrated supply chain
• Autonomous and adversarial	• Networked and collaborative
• Opaque to the outside world	• Transparent to customers and partners
• Internally focused site centric	• Externally focused market centric
• Strategically long term	• Strategically agile
• Hierarchical and information hoarding	• Knowledge creating and sharing
• Technologically constrained	• Web enabled
• Enterprise excellence	• Network excellence

In order to utilize the advantages of collaboration the buy-in and commitment of employees to the new mind-set is essential. However, to make the process a reality it is also imperative to review and redesign the new performance management systems.

Traditional methods of measuring a company's performance by financial indices alone have virtually disappeared from large organizations. Nonetheless many performance management systems are still internally focused and spend more time on direct productivity and asset utilization measures than others.

There is evidence (HBS Publishing, 2000) that the Balanced Scorecard (BSC) approach of Kaplan and Norton has made a significant impact on performance management results. Many companies benefited from applying selected metrics in the four perspectives of the BSC, viz.:

1. Financial
2. Customer
3. Internal processes
4. Learning and growth

This fundamental approach has proven to be sound where strategy is aligned with operation and external factors are shaping internal processes. But there are still implementation challenges to be tackled including:

- Too many measures lead to number games
- Few measures fit all organizations
- Lack of clarity and common definition of metrics
- Continuous change of requirements

According to a recent study (Howard et al., 2000) many performance management systems are 'receiving a failing grade' and about half of these measurement systems are still too inwardly focused. They seem to concentrate on past performance but offer little insight into how companies are likely to perform in the future. As a result, many companies are missing competitive opportunities.

The collaborative culture of the integrated supply chain has triggered the emergence of new measures particularly in five key areas:

1. *External focus*: The perception of performance is what and when delivered to customer and not how efficiently the product is made. Customers are demanding order fulfilment (not just on-line transaction efficiency) with end-to-end visibility of demand and supply.
2. *Power to the consumer*: Consumers now wish to exercise a global choice of suppliers with data for comparative performance rather than supplier specifications. It has become important to provide access to instant information.
3. *Value-based competition*: There is evidently more emphasis on the speed and quality of service than cost or quality. In addition, the competitive advantage is now the delivery time and customer relationship management (CRM).
4. *Network performance*: World class manufacturing at factory level is not sufficient. Presently success depends on a unit performing as an integral part of the network. The gradual increase in outsourcing is creating more dependence on network performance.
5. *Intellectual capital*: The sustainable success of a company has now shifted to the intellectual property and people culture of the company rather than its physical assets.

The impact of new measures on the collaborative supply chain is contributed less by the new metrics and significantly more by the way they are managed. For example, one new metric is the direct feedback from customers via automatic reply cards in the Internet or CRM systems. However, this new data does not add any value unless appropriate actions are taken with a significant paradigm shift from 'measurement' to 'management'. A six-step cycle is recommended in order to implement and sustain the benefits of a performance management system with new measures.

Benefits of S&OP

The quantifiable benefits of S&OP and CPFR in increasing customer service and sales and reducing inventory levels have been well reported and some of these have been shown earlier. Intangible benefits are perhaps more significant because S&OP, properly established, provides a level of integration between the short-term operational plans and the long-term business plans allowing multi-functional managers and trading partners to simultaneously evaluate risks and opportunities. Although S&OP may not provide a complete solution in it highlights uncertainties for investigation. If uncertainties it cannot be removed, at least information for the decision-making process is provided and alternative courses of action can be compared.

Some of the major intangible benefits of S&OP are:

1. S&OP provides a practical up-to-date review of the operational plan of an organization while meeting the business objectives of profitability, productivity and customer service.
2. It provides more timely and informed decision-making with more accurate budgets, leading to reduced emergency and contingency costs on capital projects.
3. It allows an excellent forum for senior managers of all functions to synergistically to work to a common objective and to integrate the building blocks of supply chain management. The 'finger pointing' culture is thus eliminated.
4. It is data driven and based on a 'single set of numbers' for all departments and thus helps to reconcile disputes and planning issues.
5. It can play an effective role in sustaining the high level of performance achieved by a TQM (total quality management) or Six Sigma related programme.

Summary

In this chapter, we have described the need of a company-wide data driven process, such as S&OP led by the top management to integrate all the building blocks of the supply chain and to ensure sustainable customer service at an appropriate cost and quality of products or services. The process includes a single set of data over a planning horizon of around 2 years, for all functions, such as Marketing, Purchasing, Manufacturing, Logistics and Finance. There is a clear distinction between the S&OP process and an S&OP meeting. The process involves data preparation and then review in a series of meetings in progressive steps (e.g. new products planning, demand planning, supply review, pre-S&OP and S&OP) and an S&OP meeting is part of the S&OP process.

Although its origin is in MRPII an adapted version of S&OP can be, and has been, applied in service organizations to achieve remarkable benefits in the supply chain. A service organization is likely to have a business plan, a sales forecast, a capacity plan for resources and above all customers and suppliers, thus an appropriate S&OP process is possible.

The extended supply chain supported by e-supply chain network and CPFR systems can only be effective if the S&OP process of the OEMs also include key suppliers and customers. The visibility and instant access of supply chain data and targets by stakeholders will only be more productive when the plans and their exceptions are reviewed and agreed as part of the S&OP process.

Beginning the S&OP process requires a significant effort of all departments in managing initial education, self-assessment, data preparation and scheduling meetings. The initial meetings are likely to expose two problem areas. First, the format, timing and accuracy of data will take a few cycles to become stable. Second, managers will be defensive when the performance targets in their departments are not achieved. Over time data accuracy will improve and the finger pointing and excuses will gradually disappear. It is therefore sensible to start the monthly cycle meetings at an early scheduled date than waiting for data to improve. Whenever a forum is operated in a positive manner with top management leadership continuous improvement will follow.

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Supply chain performance

It is generally considered that performance measurement for a supply chain is difficult to assess over the whole supply chain, but that each component of the chain should be able to measure with some confidence the performance of its section of the supply chain. This chapter says that it is possible to devise a set of measurements that can be used to determine in one sense the efficiency of the chain as a whole, and in another sense provide measurements of performance at each level designed to foster internal efficiency which in turn will improve the performance of the overall chain. This chapter is presented in three sections. The first section of this chapter deals with how performance is measured at organizational level, the second section considers the supply chain as a process, and the third section considers various approaches to implement improvements and methods to maintain benefits.

Measures of performance

Basic operational objectives

In operations management (see Chapter 8), the twin objectives of an operation are customer service and resource utilization, and there are many methods of measuring the performance of both these objectives. From the customer's perspective, customer service is measured in basic terms of specification, cost and time. The measures are centred on:

- *Specification*: Did the product or service meet specification?
- *Cost*: How much did it cost relative to other suppliers?
- *Time*: Was delivery on time and/or how long did we have to wait for our order or request to be addressed?

From the supplier of the product or service the specification, cost and time are measured but with a different perspective, that is:

- *Specification*: How well do we meet the standards of customer specification which have been set by us?
- *Cost*: That is what we can afford to give and what we are prepared to give. Is our price right, that is are we too cheap or too expensive. And can we increase the price without losing sales?

- *Time*: What is our percentage for on-time delivery and how long do we keep the customer waiting before we serve them or answer their queries? Are customer queues too long and are we losing business?

Thus, although customer and supplier both measure performance in terms of specification, cost and time, the reasons and therefore the approach to measurement will be significantly different.

Indeed in some cases suppliers do not truly know what their customers really want or how their customers are measuring performance. Not all organizations have a system of feedback from customers as to customer service, the argument being that as long as we are making sales and increasing our market share and providing that customer complaints are minimal why bother? Needless to say this is NOT our stance.

Our approach is customer service is the driver for an efficient supply chain.

Resource utilization

Resource utilization is measured by the operations manager in terms of efficient use of time and cost. Resources consist of:

- People
- Equipment and machines
- Vehicles
- Space
- Materials
- Inventory (input material and components, work in progress, output stocks)
- Information technology (IT)

Within the organization there will be a myriad of specific measures and areas of measurement. For a good deal of the 19th and for the 20th century, generally accountants were seen to be the conduits of information for performance measurement. The importance of financial reports and measurements contained in reports cannot be denied. Financial measures are listed in Table 19.1.

For all of the above the emphasis is on sales revenue and profit, and according to Wild (2002) all are affected by supply and demand and are dependent on the efficiency of the operation. We add that the operation in turn is dependent on the performance of the supply chain.

Operations managers although mindful of financial measures, also have their own set of measures. These can be categorized as utilization measures and performance measures as shown in Table 19.2. It will be observed that the measures used by operations are not in conflict with those used by the accountants, but are more at the tactical day-to-day level. The accountants tend to look at results as a measure of what has happened and whether plans and targets (budgets) have been achieved. Operations managers are also vitally interested in results but use measurement to influence and control so as to achieve desired results.

Table 19.1 Financial measures

Financial
Return/capital employed
Return on Assets
Net asset turnover
Profit/sales
Sales/capital employed
Sales/fixed assets
Sales/stock
Stock turnover
Sales/employee
Profits/employee
Current ratio
Gross profit
Cost of sales
Debtor days
Creditor days
Cash flow
Sales per square metre
Gearing

Table 19.2 Utilization measures and performance measures

Operations utilization measures	
Plant and machinery	Output/ throughput per hour
	Usage %
	Capacity % used
	Space occupied
	Down time (repairs, service/maintenance)
	Machine cost (capital cost/depreciation or lease cost)
	Set up time
People	Output/through put per hour
	Capacity % used
	Idle or ineffective time
	Absenteeism
	Accidents/illness
	Labour cost content
Materials	Yield %
	Waste/scrap %

(Continued)

Table 19.2 (Continued)

	Rework
	Rectification
	Recalls
	Material cost
Performance, areas to be measured	
Location	Transport costs
Layout	Movement and throughput
	Space utilization
Work methods	Value added per hour
	Accident rates
	Industrial disputes
	People required numbers and skill levels
	Employee turnover
Capacity management	Capacity available measured in possible output
	Capacity % achieved
Scheduling	On time deliveries or % of late deliveries
	Value/amount of work in progress
	Customer queue time
Materials management	Supplier performance
	Stock turn, days of stock held
	Capital tied up in stock
	Stock shortages; late deliveries of input materials leading to disruptions and delays
	Lead times (input and output)
	Late delivery to customers
	Customer queues
	Obsolescent stock (past used by date, out of fashion, out dated technology)
Quality	Reject rates
	Returns from customers
	Warranty claims
	Customer complaints
	Reworks
	Rectification and recalls
	Performance penalties
	Quality system costs
	Product tests/laboratory costs
Maintenance	Down time
	Cost of own maintenance staff and utilization of staff
	Operating hours between breakdowns per machine
	Life cycle of machine

The marketing department also has measures which include:

- Market share
- Orders on hand
- Order lead time
- Repeat business
- Number of complaints
- Warranty claims
- New product development and launch
- Time to market
- Conversion of leads to sales

Investor measurement

A critical performance measurement is made by investors (and the share market). Failure to provide a satisfactory return on investment (ROI) will lead to a drop in share price, higher funding rates and close scrutiny by investors. When an organization is under pressure to reassure the investors, and the share market, pressure will be applied to cut back on costs and to shed people. An example is Ford Motors who announced following a very poor financial result, that in 2008 it will close a further 16 factories and that up to 30,000 people will be redundant. Some reports suggest that redundancy in 2007/2008 will be as high as 75,000. Notwithstanding; redundancy of 30,000 is 10 per cent of Ford's worldwide work force of 300,000. Previously, in 2002, Ford made 35,000 redundant and closed 10 factories.

Self-centred measurement

All of the above performance measures are at one level of the supply chain, be it first, second, third tier supplier of materials, manufacturer, processor, distributor, warehousing, or retailer. Obviously, the immediate upstream provider and the immediate downstream customer will have an impact on the performance of a supply chain component and in turn each member will be judging the performance of its immediate upstream suppliers. However, the purpose of all the measures listed above, be they financial, operational, marketing or by investors is to achieve internal efficiency and ultimately to achieve an acceptable ROI.

In the simplified supply chain shown in Figure 19.1 one component of the chain, the manufacturer, measures performance of itself, and of its immediate customer and its immediate supplier. In this example the measurement is seen as being two way, but frequently measurement is self-centred and little effort is made to measure performance from the supplier or customers perspective, let alone try to measure performance for the whole supply chain!

From self-centred to supply chain centred

By now it will be clear that we view the supply chain in its entirety. The strength of the supply chain movement has been to encourage managers to think outside

3rd tier

2nd tier

1st tier supplier ➔

🡐 Manufacturer ➔

🡐 Distributor

Warehouse

Retailer

End user

Figure 19.1 Simplified supply chain.

the box, and to recognize that organizations are not an island unto themselves. Organizations are interdependent on other organizations up and down the supply chain and need to recognize financial as well as logistical limitations and advantages of inter-company including inter-national transactions. Some organizations have achieved integration of their supply chain to an advanced level from a position of dominance and power. Organizations such as Toyota and others who follow a lean 'just-in-time' approach in manufacturing and organizations such as Wal-Mart in the USA and Tescos in the UK and McDonalds worldwide have been able to control performance of their supply chain to meet their objectives.

The lean production methods of Toyota require internally a flexible work force, single minute exchange of dies (SMED), small batches, elimination of non-value adding activities, scheduling to balance the line and to reduce queues, simple easily understood control measures and feedback, and minimal stock holding (work flows like water). Continuous improvement (kaizen) is so engrained in the culture at Toyota staff are not aware of any other way of thinking! Being internally efficient is crucial to a lean system, but no lean system is possible without the co-operation of suppliers and customers. Toyota does not dictate to customers, but certainly enforces controls and standards on suppliers out to several tiers of their supply chain. Toyota requires and insists on quick response, delivery on time and delivery exactly to specification with up to 16 deliveries (hourly) required per day from immediate suppliers. Performance of all of this requires shared values, standards, targets and measures. Toyota does not neglect customer satisfaction. From the customer aspect performance is measured in two ways; from internally set standards of product quality, on time delivery and service and externally from feed back from customers. Despite all this Toyota is not perfect and is prepared to publicly admit so.

Following recalls of over 1 million vehicles in Japan and 400,000 sports-utility vehicles in the USA, Watanabe (3 August 2006), the Toyota President told a news conference 'the world class quality we have built is our life line. There will be no growth without an improvement in quality. This is the biggest task that this management must undertake'. It was advised that a new division dedicated to gathering more quickly from users information of quality problems had been set up.

The Tesco, Wal-Mart and McDonald approach is to manage the supply chain right back to when the seed goes into the ground. They do not themselves plant or harvest the seed but they tell the farmer when to plant, what variety, what fertilizers and type of pesticide to use, when to harvest and so on right down the supply chain through processing and distribution until the product reaches their retail outlets. Performance at each stage of the supply chain must comply with their standards and measurements.

Customers at supermarkets benefit from a wide range and choice of product, standardized quality of product, and prices are lower than any independent trader could hope to achieve.

Shift of criteria

A little more than a decade ago the companies were urged to attain so-called 'world class' performance within the enterprise. The departments within a company were striving for islands of excellence and then with a succession of operational excellence initiatives (e.g. total quality management (TQM), business process re-engineering (BPR), manufacturing resource planning (MRPII) and Six Sigma) the fences between departmental turf were gradually demolished. The organizations started to become customer focused and with established performance metrics in all areas of the business (e.g. 'Balanced Scorecard' (BSC)) began to emerge. However, it is fair to say that both the business model and the performance metrics were site-centric or at most were confined within the company or enterprise. The need for externally focused performance metrics from the perspective of a customer or an external supplier was identified. Unfortunately in most companies in practice these metrics were not implemented beyond mere lip service.

However, with web-based technologies now accelerating the collaborative supply chain, it is becoming imperative to rethink the selection and implementation of the external metrics. This shift is not only in the measurement criteria, but also in the mind-set of business practices. Collaboration requires a capacity to 'work in association, sometimes, with an enemy' and does not achieve its business success at the competitor's expense. Figure 19.2, adapted from Basu

Enterprise	Integrated supply chain
❑ Autonomous and adversarial	❑ Networked and collaborative
❑ Opaque to the outside world	❑ Transparent to customers and partners
❑ Internally focused site centric	❑ Externally focused market centric
❑ Strategically long-term	❑ Strategically agile
❑ Hierarchical and information hoarding	❑ Knowledge creating and sharing
❑ Technologically constrained	❑ Web enabled
❑ Enterprise excellence	❑ Network excellence

Figure 19.2 Shift of performance criteria.

(2003) summarizes some specific areas where performance criteria have shifted along with changes from the enterprise-centric business to the collaborative supply chain.

In order to utilize the advantages of collaboration, the buy-in and commitment of employees to the new mind-set is essential. However, to make the process a reality it is also imperative to review and redesign the new performance management systems.

Agile supply chains

All of the above examples are agile supply chains, and each is dominated by a key player. The characteristics of an agile supply chain are quick customer response at each level of the chain, flexibility, scheduling triggered by customer demand, open and real-time information flow, simultaneous new product development, and as Morgan (2004) says pipeline cost improvements. If agile is to be achieved measurement and control, or at the least monitoring of performance, is necessary.

Morgan (2004) also injects a dose of reality. He says that 'very small organizations do not have the time, resources or information to undertake the analyses required for optimization activities. Medium sized enterprises may have the information as their management systems develop, but can lack the skills to interpret and apply it' While we agree with Morgan we add that no matter how efficient and well intentioned a small or even a medium sized enterprise is, that it is not likely that they can get a Wal-Mart or a McDonalds to dance to their tune.

Supply chain as a process

Perfect order and perfect supply chain

A perfect order begins with raising the product order, electronic data interchange (EDI), correct transaction codes, all items available, correct picking of items, transport available, paperwork complete and correct, delivery at right temperature, arrives on time, is undamaged, invoices correct and payment made on time. Outside of Toyota and some other world class companies 100 per cent perfect delivery is rare. If we accepted that 95 per cent performance is good then in a supply chain of six levels each performing at 95 per cent the end result is 73.5 per cent efficiency. If 98 per cent efficiency is achieved at each level then efficiency is 88.6 per cent. For Toyota anything less than Six Sigma at each level is not acceptable. Six Sigma equates to 99.9996.6 per cent or 3.4 errors per million opportunities, in effect zero defects. However, Toyota does not expect Six Sigma to be achieved for every activity. Likewise nor do we, our approach is FIT SIGMA. With FIT SIGMA philosophy (Basu and Wright, 2003) it is not necessary to achieve Six Sigma for every activity, some activities are not critical, others are. The approach is to understand which activities are critical, determine the level of performance of these activities, strengthen those that are weak and build on those that are strong. FIT SIGMA is explained in greater detail in the section ‘Making it happen’ of this chapter.

Process-based approach

There are two ways of measurement, one is to measure activities, and the other is to identify and measure processes. The process-based approach concentrates on the process rather than activities. A complete supply chain is a process. The very name supply chain indicates one entity managed as a whole and not a series of self-centred entities managed independently. The desired end result of the process for a supply chain is to satisfy the customer with the delivery of a perfect order.

In a simplified supply chain the process to satisfy a perfect order is:

Supplier
→ Inward logistics
→ Factory
→ Outward logistics
→ Warehouse
→ Retailer
→ End user

From supplier through all the levels of the supply chain out to the end user is the process.

Each component in the overall process will have to carry out a set of activities and as shown earlier in this chapter each component will have a set of measurable standards.

These financial, operational and marketing performance measures although inward looking if taken with a determination to correct and improve will lead to an efficient use of resources and will facilitate customer satisfaction. As explained the achievement of high standards of performance rely to a large extent on demand and supply. Thus, many of the standards and measurements for own performance can without much effort be related to the viewpoint of the immediate supplier and the immediate customer. If each component takes a customer centric view a perfect order will achieve:

- *Specification*: Customer specification will be 100 per cent.
- *Price*: The price will be better than or at least comparable to the competition.
- *Time*: Delivery will be in full and on time.

Sounds familiar? Refer back to the opening paragraphs of this chapter. If each component is achieving the delivery of a perfect order, then the process as a whole, that is the complete supply chain process can be said to be performing to the customers satisfaction, as indeed it appears to do for customers of Wal-Mart, Tescos, McDonalds and Toyota. Bearing in mind each component is a customer of another component, and each component will be getting their desired level of service in the form of a perfect order from upstream. To achieve this desired state it follows that each component internally will be continuously improving it's own efficiency in the use of resources.

Chan and Qi (2003) have developed a scoreboard type approach for process-based measurement of the supply chain. Their dashboard consists of seven elements, namely cost, time, capacity, capability, productivity, utilization and outcome:

- *Cost – inventory carrying costs*: Inventory management accounts for a mass of total materials handling costs. Effective management should achieve lower costs. Hence, inventory carrying costs deserve much attention in assessing performance of inventory management. Inventory capital cost, storage space cost, and risk cost are the three key parts of inventory carrying costs.
- *Time – flow rate*: Inventory flow rate is based on ratio of the inventory level (in terms of stock units or value) to average inventory cycle time. Flow rate is an indicator of cycle time of inventory within the warehouse. The faster inventory flows through the warehouse, the lower investment on inventory and the improved investment on inventory returns.
- *Effectiveness – inventory accuracy*: This concerns inventory record errors when physically cycle counting and checking at regular intervals. Maintaining high inventory accuracy is critical, not only for financial controls, but also for effectiveness of subsequent materials requirement planning and order delivery. Inventory accuracy indicates the effectiveness of both physical inventory management and documentation management.
- *Availability – inventory availability*: Availability is one of the most important performances from the customer viewpoint. Inventory availability indicates the customer service level and is largely concerned with customer satisfaction. The two often-used measures are order fill rate (order availability) and stockout rate (stock unit availability). The former is based on the percentage of demand order filled from stock in total. The latter refers to the rate of stockouts and the duration of stockouts.
- *Productivity – inventory productivity*: For the inventory management process, which consumes a great amount of inputs: labour, facilities, capital, space, and energy, assessing its productivity is indispensable traditionally. The total productivity, multi-factor productivity, and partial factor productivity, all need to be measured.
- *Utilization*: Most of the resources, which inventory management process consumes, deserve attention in utilization. Besides utilization of labour, facilities, and capital, there are two more: working inventory rate and stock unit utilization. The former is based on the percentage of working inventory in the total inventory held. It indicates the effectiveness of inventory holding strategies. The latter refers to the storage space utilization, which indicates the effectiveness of storage policies.

Chan and Qi add that 'metrics are selectively adopted according to the management and measurement emphasis' (p. 187).

So far in this chapter we have shown that traditional measurement, be they financial, operational marketing or from the investors perspective are self-centred and based on specific activities. Although some effort will be made by most companies to measure immediate customer satisfaction, it is difficult for organizations to measure the performance of the supply chain. Indeed if an organization is not in a dominant position in the supply chain there is little chance that it can influence the performance of the supply chain in its entirety. However, the supply chain taken as a process can be measured. We provided a dashboard of measurements. If each member of the supply chain is measuring its own internal activities with the express aim of continuous improvement and is delivering a perfect order to its customers, it follows that the supply chain as a whole will be customer centric. The result being that the entire process of the supply chain will be geared towards delivering perfect orders to the end user. Each player in the supply chain will benefit by being leaner and more profitable.

The premise being that if each component is internally efficient and determined to deliver perfect orders, beginning with the original supplier flowing down through each component of the chain out to the end user that the entire chain will be efficient and each player will benefit.

Making it happen

The first section of this chapter deals with how performance is measured at organizational level, the second section considers the supply chain as a process and process-based measurement, the third section considers how an organization can self evaluate and become efficient.

Theory of constraints

The theory of constraints (TOC) is a management philosophy developed by Goldratt (1992). The theory is that the output of an organization is limited (constrained) by internal resources, market factors and by policy. Resource constraint means not enough resources to meet demand, market constraints mean capacity is more than the market demands, and a policy constraint (i.e. a policy of no overtime) can limit output. TOC tries to improve system performance by focusing and eliminating constraints. In service operations where it is often difficult to quantify the capacity constraint, TOC can be very useful. For companies that employ skilled workers and for many service organizations the constraint is often the time of one or a few key employees. The key steps in this process are:

1. *Identify*: The first step in applying TOC is to identify the constraining factor (bottleneck department or section).
2. *Exploit*: Determine the throughput per unit of the constraining factor (by department or section of a department).

3. *Subordinate*: Prevent the resources needed from waiting in a queue elsewhere (i.e. backing up at a non-constrained resource).
4. *Elevate*: If the constraint still exists find ways to increase the capacity of the constraining section.
5. Go back to Step 1.

Implementation of TOC, although simple in principle, is often difficult because it may require a complete change in the way an organization operates. For example, TOC requires a shift from cost-based decision-making to decision-making based on continuous improvement.

As discussed in the section 'Measures of performance' of this chapter, a company's performance is measured in financial terms. Quarterly or annual financial reports create an immediate impact on the share value of the company and consequently senior managers are driven to improve the share price. Thus, the traditional accounting model of balance sheets and profit and loss performance statements are still used to judge the success of management and of the organization. By their very nature these are backward-looking historical documents. Thus, although we operate in an age where information is close to being real time, performance is still judged on past results.

Kaplan and Norton (1996) argued that 'a valuation of intangible assets and company capabilities would be especially helpful since, for information age companies, these assets are more critical to success than traditional physical and tangible assets'. They created 'The Balanced Scorecard' (BSC) which retains traditional financial measures, customer services and resource utilization (internal business process), and also includes additional measures for learning (people) and growth (innovation). This approach complements measures of past performance with drivers for future development.

The Balanced Scorecard

The concept of the BSC was first introduced by Kaplan and Norton in an article in the *Harvard Business Review* in 1992, *The Balanced Scorecard – Measures that Drive Performance*. This generated considerable interest for senior business managers and led to the next round of development of the scorecard. The focus was shifted from short-term measurement towards generating growth, learning and value-added services to customers. This methodology was then published by Kaplan and Norton in a number of articles in the *Harvard Business Review* and culminated in their 1996 book *The Balanced Scorecard*. Many companies are now using the BSC as the central organizing framework for important decision processes. The evolution of this technique has gradually transformed the performance measurement process into a strategic management system. The BSC is a conceptual framework for translating an organization's strategic objectives into a set of performance indicators distributed among four perspectives (see Figure 19.3):

1. Financial
2. Customer

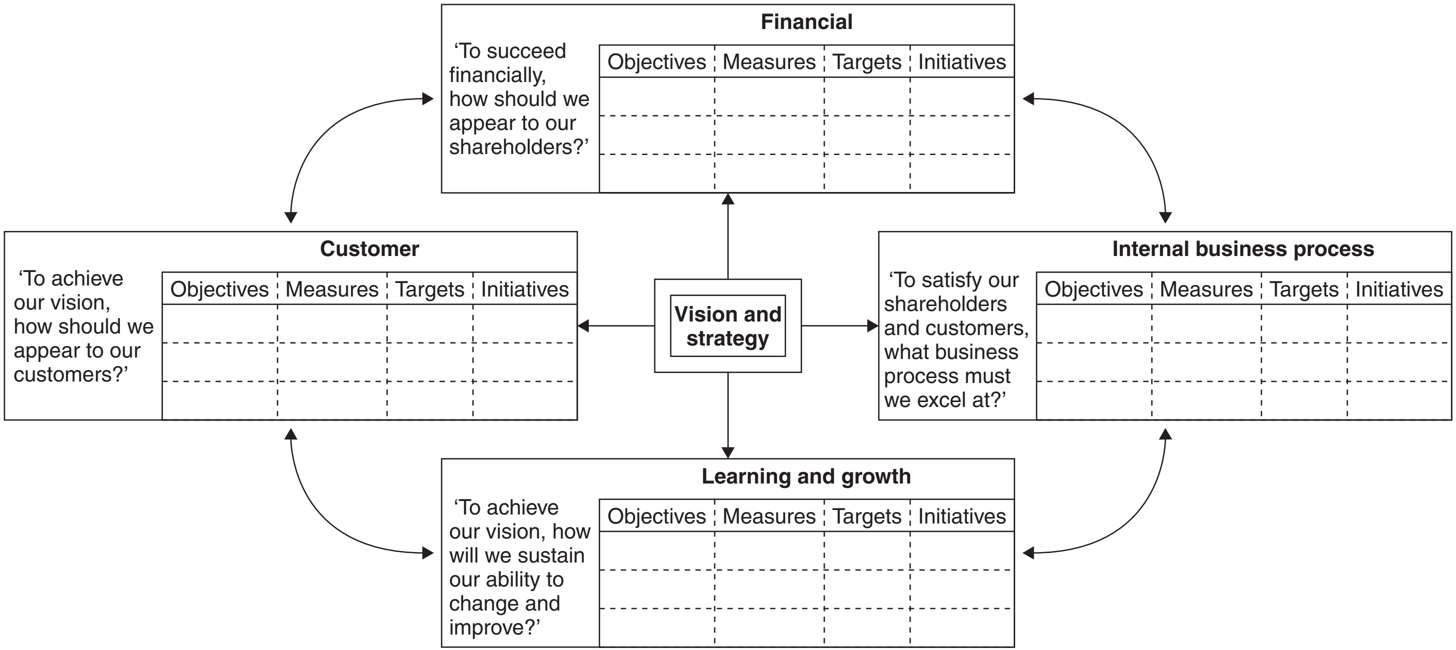

Figure 19.3 Balanced Scorecard.
Source: Kaplan and Norton, California Management Review (1996).

3. Internal business processes
4. Learning and growth

The indicators are aimed to measure an organization's progress towards achieving its vision as well as the long-term drivers of success. Through the BSC an organization monitors both its current performance (e.g. internal processes, finance and customer satisfaction) and its effort to improve and sustain performance (e.g. innovation and employee development). It is also balanced in terms of internal efficiency and external effectiveness. Later Norton (1999) extended the elements of the overall scorecard to six, these being:

1. ROI
2. Budget
3. Shareholder value
4. Customer
5. People
6. Quality

Targets (scores) are formulated for each element, communicated and consensus achieved, executed and results are evaluated with corrective action taken so that the targets (scores) are achieved. Norton says that it is important that all elements are linked and not considered in isolation. The BSC has been applied successfully in several organizations around the world. It is evident that the key performance indicators (KPI) of both manufacturing and service organizations, as we have described earlier, can be incorporated in to a properly designed BSC. The scorecard, with some customized changes, provides a management tool for senior executives primarily to focus on strategies and longer-term objectives. The organizations could vary from a large multinational business to a non-profit-making public service unit. The scorecard is sometimes named the 'Executive Dashboard'. The KPI are reported as:

- Current actual
- Target
- Year-to-date average
- Variance to YTD target

When the actual performance value is on or above target then the value is shown as green. If the actual is below the target but within a given tolerance then the colour becomes amber. It is depicted in red when the value is below the tolerance limit of the target. Another area of application is to assess the performance at the tactical operation level. Usually the top level indicators (also known as 'vital flow') are designed in such a way that they can be cascaded to 'component' measures and the root causes can be analysed. Basu (2002) emphasized the impact of new measures on the collaborative supply chain. The Internet-enabled supply chain or e-supply chain has extended the linear flow of supply chain to collaborative management supported by supplier partnerships. This has triggered the emergence of new measures especially in five areas:

1. External focus
2. Power to the consumer
3. Value-based competition and customer relationship management
4. Network performance and supplier partnership
5. Intellectual capacity

The design features and application requirements of the BSC can be adapted to the collaborative culture of the integrated supply chain (see Chapter 13).

Total Operations Solutions

Total Operations Solutions (Basu and Wright, 2005) enables self-assessment against 20 defined areas (called 'foundation stones') to identify areas of improvement for achieving the full potential of the business. The business is built from these foundation stones up, and consists of the 'six pillars' of Total Solutions. The pillars are:

1. Marketing and innovation
2. Supply chain management
3. Environment and safety
4. Facilities
5. Procedures
6. People

Self-assessment is done through 200 questions, 10 for each foundation stone. Although the checklist is aimed at manufacturing operations, it can be adapted easily to service operations. From scores for each foundation stone current performance gaps are determined. Example of the questions used are shown in Table 19.3. Note two of these questions were given in Chapter 5 and are marked with * symbol.

Table 19.3 Sample self assessment questions

	Poor				Excellent
How good is your integrated point of sale system?	0.1	0.2	0.3	0.4	0.5
*How effective is the inclusion of key suppliers in the planning process?					
*How effective are you in the sharing of common coding and databases with suppliers and customers using Internet or EDI?					
How effective have you been in the co-development of new product?					

(*Continued*)

Table 19.3 (Continued)

	Poor				Excellent
How effective are you in sharing risks and cost savings with your suppliers?	0.1	0.2	0.3	0.4	0.5
How good are you in meeting delivery as determined by customers?					
How well do you work with suppliers to improve each others processes?					
How satisfactory is your post-delivery performance in terms of invoice accuracy?					
How well do you record and seek causes for return of goods and/or customer complaints?					
How well is cost of non-conformance to quality standards communicated to staff (cost of rework, scrap, replacement, overtime and lost business)?					
How cost-efficient is your distribution operation when distribution cost is expressed as a percentage of sales? (Over 8% is poor, less than 1% is excellent)					
How easy is it for customers to contact the right person in your organization when they want to place an order or need knowledge of your product?					

With Total Operations Solutions larger projects are selected based upon an organization's strategic goals and requirements. The viability of the project is then established based on certain quantifiable criteria including ROI and strategic goals. With Total Operations Solutions, before any improvement project is commenced five factors are considered:

1. What is the project's value to the business in terms of overall financial performance? This factor can be applied by monitoring the savings on a monthly basis.
2. What resources will be required? How much will they cost? The time scale of the project is also included in this factor.
3. What metrics will be used to monitor the performance of specific large projects? Examples are DPMO (Defects Per Million Opportunities) and RTY (Rolled Throughput Yield).
4. What will the impact be on the external market? It will be important to monitor customer service and sales revenue to ensure that there is no erosion due to key people's commitment to the project.
5. That the project does not take on a life of its own, and that it continues to align with the overall mission and strategy of the business.

A recurring challenge for companies who have invested significant time and resources in implementing proven improvement plans such as Total Operations Solutions or Six Sigma is how to ensure sustainable performance beyond the duration of a one-off corporate exercise. The annual review of the change programme during the budget planning is ineffective because 12 months is a long time in a competitive market place. In order to steer the benefits of the programme and the business objectives to a sustainable future, the senior managers who are in the driving seats must have a clear view of both the front screen and the rear view mirrors and they must look at them as frequently as possible to decide on their direction and optimum speed. In recent years, the pace of change in technology and the market place dynamics have been so rapid that the traditional methodology of monitoring actual performance against predetermined budgets set at the beginning of the year may no longer be valid. It is fundamental that businesses are managed based on current conditions and up-to-date assumptions; there is also a vital need to establish an effective communication link, both horizontally across functional divisions and vertically across the management hierarchy, to share common data and decision processes. A solution to these continuous review requirements recommended in Total Operations Solutions is sales and operations planning (S&OP) as described in Chapter 18.

Self-assessment and certification

In order to maintain a wave of interest in the quality programme and also to market the competitive advantage of quality, many companies dedicated the effort to the pursuit of an approved accreditation such as ISO or an award such as the Malcolm Baldridge Award (in the USA) and derivatives of the Baldridge Award in other countries. The certification and awards have had a chequered history. After a peak in the early 1990s, the Baldridge Awards gradually lost their impact in the USA and companies (e.g. GE, Johnson & Johnson) started developing their own customized quality assessment process. Encouraged by the customer demand for the ISO stamp of approval there was a rush for ISO 9000 certification in the 1990s, but companies became disillusioned by the auditors ensuring compliance with current procedures without necessarily improving standards. A number of consultancy companies attempted to introduce their own awards to progress an improvement programme (e.g. Class ‘A’ by Oliver Wight).

European Foundation of Quality Management

The EFQM (European Foundation of Quality Management) award is derived from America’s Malcolm Baldridge National Quality Award. There are similar accolades available in other countries, such as the Canadian Excellence Awards and the Australian Quality Award. The EFQM Award was established in 1991. It is supported by the European Union and the countries in the EU have their own support unit (e.g. British Quality Foundation in the UK). The EFQM model provides a set of checklist questionnaires under nine categories, each containing maximum points. They are:

Leadership	100 points
People management	90 points
Policy and strategy	80 points

Resources	90 points
Processes	140 points
People satisfaction	90 points
Customer satisfaction	200 points
Impact on society	60 points
Business results	150 points
Total	*1000 points*

The first five categories (leadership to processes) are ‘enablers’ and the remaining four categories are ‘performance’ related.

FIT SIGMA (Basu and Wright, 2003)

Six Sigma is a whole system approach to improvement of quality and customer service so as to improve the bottom line. Like all total quality programmes Six Sigma takes a whole systems approach and requires a culture whereby everyone at all levels has a passion for continuous improvement with the ultimate aim of achieving perfection. Six Sigma sets a performance level that equates to 3.4 errors per million opportunities. FIT SIGMA recognizes that not every organization needs the intensive and expensive ‘all or nothing’ investment required to achieve Six Sigma. With FIT SIGMA we identify key areas where zero defects are essential and areas where zero defects are possible, but we also recognize that there are areas where zero defects are not essential or practical. We say rather than the organization having to strive to fit a mathematical formula that Six Sigma should be adapted to meet the needs of the organization. Programme comprises the following features:

1. Establish the policy of external certification such as EFQM or customized self-assessment such as Total Operations Solutions.
2. Develop or confirm the checklist of assessment.
3. Train internal assessors in the common company assessment process (one assessor for every 500 employees as a rough guide). The assessors should also carry out normal line or functional duties.
4. Train experts (Six Sigma trained Black Belts) and department managers in the self-assessment checklist and process.
5. Carry out quarterly self-assessment by departmental managers.
6. Ensure six-monthly (at the initial stage) and annual (at the later stage) assessment by the internal assessors.
7. Analyse gaps and implement measures to minimize the gap.
8. Consider corporate awards, depending on the performance attained.
9. Review the checklist with the change of business every 2 years.
10. Consider external accreditation *only* if it adds value to the business.

The above methodology is applicable to all types of business, both manufacturing and service, and all sizes of operations, whether large, medium or small. A larger organization is likely to have its own resources to develop and maintain the process; a smaller organization may require the assistance of external consultants to develop the process.

Signature of quality

Signature of quality (SoQ) is another approach and is illustrated by the following case example.

Case example: Janssen–Cilag

Janssen–Cilag applies (SoQ) for continuous self-improvement Janssen–Cilag is the pharmaceutical arm of the American Johnson & Johnson Group of companies with their European Head Office based in High Wycombe, UK. Janssen–Cilag is among the top ten pharmaceutical companies in the world.

The company markets prescription medicines for a range of therapeutic areas of gastroenterology, fungal infections, women's health, mental health and neurology.

The commitment of the company to the values and standards laid out in 'Our Credo' drives management to strive continually for excellence in a number of overlapping areas. Based upon the principles of the Baldridge Award, the Quality Management team of Janssen–Cilag developed a self-assessment process known as 'Signature of Quality'. The process is supported by a checklist on a carefully constructed questionnaire in five interdependent areas:

1. Customer focus
2. Innovation
3. Personnel and organizational leadership
4. Exploitation of enabling technology
5. Environment and safety

SoQ is managed as a global process from the USA office and each site is encouraged to prepare and submit a comprehensive quality report meeting the requirements. The assessment is carried out by specially trained Quality Auditors and a site may receive an SoQ Award based upon the results of the assessment.

SoQ has been reported to be successful in Janssen–Cilag as a tool for performing a regular 'health check' and as a foundation for improvement from internal benchmarking.

Case from Basu and Wright (2003)

Knowledge management

Our final comment in this chapter is that knowledge once gained is too important to lose. The key principles of knowledge management are:

1. Systematically capture knowledge from proven 'good practices'.
2. Select examples of best practice which provide added value to the business.
3. Inculcate knowledge between all functions.

It is essential to establish a learning organization culture. Unless staff at all levels are sharing in knowledge, and truly believe that the business can benefit from shared knowledge, the gathering of knowledge will have achieved little. If an organization believes that they already know what the best practice is and are satisfied with incremental improvement they will be left behind. History shows that knowledge progresses in leaps and bounds. The development of a learning culture does not just happen, words are not enough. The support structure required to develop a knowledge-sharing culture needs:

- A champion as a focal point to coordinate the process.
- Regular 'best practice' forums, to promote learning, sharing and networking.
- Internal and external benchmarking using one of the approaches detailed above.
- Continuous communication through websites, newsletters, etc.

The development of a learning organization culture does not happen overnight. It takes time and requires support. Our experience is that time and money spent in knowledge management is an investment in the most valuable resource of competitive advantage – people.

Supply Chain Operations Reference

The Supply Chain Operations Reference model (SCOR®) has been developed by the Supply Chain Council to describe the business activities associated with all phases of satisfying a customer's demand. The model itself contains several sections and is organized around the five primary management processes of Plan, Source, Make, Deliver and Return. By describing supply chains using these process building blocks, the model can be used to describe supply chains that are very simple or very complex using a common set of definitions. As a result, disparate industries can be linked to describe the depth and breadth of virtually any supply chain. The model has been able to successfully describe and provide a basis for supply chain improvement for global projects as well as site-specific projects.

The SCOR model contains five levels of analysis.

Level 1: Process type

The top level of SCOR plan defines the five fundamental perspectives of Plan, Source, Make, Deliver and Return:

- *Plan*: Planning of demand and supply balance.
- *Source*: Process to source product or service.

- *Make*: Process to make materials into product.
- *Deliver*: Process to provide product or service.
- *Return*: Process for purchasing to return material or for distribution to receive reject products.

Level 2: Process categories

The second level of SCOR is configuration of process categories. For example, the manufacturer under the Make section could select a strategy of 'making to stock' or of 'making to order'.

Level 3: Process elements

In the third level of SCOR every process is divided into detailed process elements. For example, 'source to stock' category is divided into five elements, namely scheduling material, receiving material, checking material, stocking and payment.

Level 4: Implementation

The fourth level is implementation between partners of the supply chain. From January 2007 organizations using SCOR have had access to benchmark metrics.

Level 5: Performance metrics

SCOR model provides a set of five metrics for process level, called SCORCard, for evaluating supply chain performance. The five metrics are reliability, responsiveness, flexibility, cost and assets.

For further information of the SCOR® model see www.supply-chain.org.

Capability Maturity Model Integration

According to Wikipedia, The United States Air Force funded a study at the Carnegie-Mellon Software Engineering Institute to create a model for the military to use as an objective evaluation of software subcontractors. The result was the Capability Maturity Model (CMM) which has been superseded by the more comprehensive Capability Maturity Model Integration (CMMI).

The CMM can be used, especially in large IT projects, to assess an organization against a scale of five process maturity levels. Each level ranks the organization according to its standardization of processes in the subject area being assessed. The five levels of maturity are:

Level 1: Initial

At maturity level 1, processes are usually *ad hoc* and the organization usually does not provide a stable environment. Success in these organizations depends on the competence of the people in the organization and not on the use of proven processes.

Level 1 software project success depends on having high quality people.

Level 2: Repeatable

At maturity level 2, software development successes are repeatable. The processes may not repeat for all the projects in the organization. The organization may use some basic project management to track cost and schedule.

Basic project management processes are established to track cost, schedule, and functionality. The minimum process discipline is in place to repeat earlier successes on projects with similar applications and scope. There is still a significant risk of exceeding cost and time estimates.

Level 3: Defined

The organization's set of standard processes, which is the basis for level 3, is established and improved over time. These standard processes are used to establish consistency across the organization. Projects establish their defined processes by the organization's set of standard processes according to tailoring guidelines.

A critical distinction between levels 2 and 3 is the scope of standards, process descriptions and procedures. At level 2, the standards, process descriptions and procedures may be quite different in each specific instance of the process. At level 3, the standards, process descriptions and procedures for a project are tailored from the organization's set of standard processes to suit a particular project or organizational unit.

Level 4: Managed

Using precise measurements, management can effectively control the software development effort. In particular, management can identify ways to adjust and adapt the process to particular projects without measurable losses of quality or deviations from specifications. Organizations at this level set quantitative quality goals for both software process and software maintenance.

A critical distinction between maturity level 3 and maturity level 4 is the predictability of process performance. At maturity level 4, the performance of processes is controlled using statistical and other quantitative techniques, and is quantitatively predictable. At maturity level 3, processes are only qualitatively predictable.

Level 5: Optimizing

Maturity level 5 focuses on continually improving process performance through both incremental and innovative technological improvements. Quantitative process-improvement objectives for the organization are established, continually revised to reflect changing business objectives, and used as criteria in managing process improvement. The effects of deployed process improvements are measured and evaluated against the quantitative process-improvement objectives. Both the defined processes and the organization's set of standard processes are targets of measurable improvement activities.

A critical distinction between maturity level 4 and maturity level 5 is the type of process variation addressed. At maturity level 4, processes are concerned with addressing special causes of process variation and providing statistical predictability of the results. At maturity level 5, processes are concerned with addressing common causes of process variation and changing the process to improve process performance to achieve the established quantitative process-improvement objectives.

Summary

This chapter has addressed the various measures of performance including hard and soft measures and the selection of appropriate measures should depend on the specific supply chain of the organization. The supply chain performance is also shown to be a process of integrating the building blocks and stakeholders of the total supply chain, and that if each member of the process is efficient and is dedicated to passing on a perfect delivery the process as a whole will be efficient. It is accepted that few players in a supply chain can dominate or control another player. However each player can strive to become more efficient in their activities. To become efficient it is first necessary to know our existing level of performance and to identify gaps in performance. Various approaches for self-analysis were explained and illustrated. Analysis is the first step, improvement (getting fit) is the next, and staying fit is the final stage. This chapter shows how FIT SIGMA can be used to maintain fitness. We concluded with a section on the importance of knowledge management.

20

Case study examples

Introduction

In preceding three chapters we aimed to establish how Systems and Procedures (Chapter 17), Sales and Operations Planning (Chapter 18) and Performance Management (Chapter 19) act as integrators of the building blocks of total supply chain management. In this chapter, we illustrate the interdependency of the building blocks with two case studies. The first case study is based on the experience of a pharmaceutical company to deal with all aspects of supply chain management by applying appropriate good practices relevant to each building block. The second case example is a variation of the well-known beer game (Senge, 1990) to illustrate how the stakeholders (e.g. factory, warehouse, distributor and retailer) are dependent on the forecasts, processes and inventories of one another.

Total supply chain case study

Background

A multinational pharmaceutical company in Turkey (herein after referred as 'the company') was awarded MRPII (manufacturing resource planning) 'Class A' certification in 1999 by business education consultants Oliver Wight (OW), Europe. The application of sustainable behavioural and performance metrics was applied to monitor and facilitate the attainment of MRPII to Class A status.

As part of the MRP II Class A programme, GSK (GlaxoSmithKline) Turkey installed a sales and operations planning (S&OP) process which is underpinned by a set of business planning meetings at various levels. The company went through major changes following the 'Class A' award including the global merger with another multinational pharmaceutical company and the corporate Lean Sigma programme. In spite of these seismic changes, the S&OP process has been continued by the company every month.

The rigour of the S&OP process which is championed by the Managing Director has helped the company to sustain and improve the business benefits and communication culture especially when they were challenged by a number of local initiatives in hand, including:

- Transfer of head office
- Rationalization of factory and warehouse
- New products introduction
- Mobile network for sales force

The organization structure of the company in general remained the same with some changes in personnel after the merger as shown in Figure 20.1.

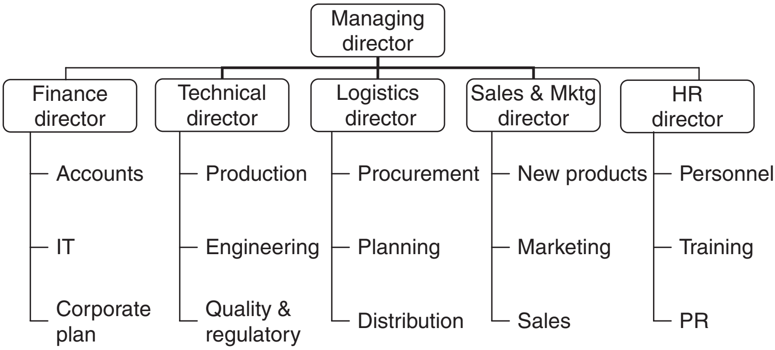

Figure 20.1 The company in Turkey organisation chart.

Project scenario

However the situation was quite different with the company in late 1990s. During the growth period of a blockbuster drug, a manufacturing plant was installed in 1984 at Gebze, an industrial town approximately 80 kilometres from the head office in Istanbul. The Gebze factory gradually expanded to accommodate manufacturing and secondary packing facilities for antibiotics and tertiary packaging of imported corporate products for the local market. By the beginning of 1997 Gebze factory was producing nearly 25 per cent of the company turnover of over $100 million. A distribution warehouse was built in 1992 at the Gebze site and this was managed by the Logistics Department of the company. With the assistance of a local software consulting firm the Information Technology (IT) Department implemented the financial module and limited planning modules of an ERP system called *MFG-Pro*. Although the company was enjoying a period of growth both the internal communication and external customer service were not satisfactory. Some of the problems and challenges were:

- The customer order fill was only around 85 per cent while the stock cover was over 6 months.

- The communication and inter-personal relationship between the head office (Istanbul) and the factory (Gebze) was poor.
- The distribution warehouse appeared to require additional storage capacity and modernization.
- Although an ERP system (*MFG-Pro*) was operational but it was not effective because of poor data accuracy and lack of understanding of the functionality.
- The company depended heavily on the supply from Corporate Export (based in Ware, England) who could not assess the priority of the company in Turkey.
- The corporate Global Supply Chain Programme (which required Y2K enabled 'legacy' or new systems) demanded considerable resources from the company in Turkey.

The challenges were compounded by an audit report by Food and Drug Administration (FDA) of United States. During an audit of the computer systems of an European factory supplying to the US market FDA issued an warning (Form 483) regarding the batch validation of the MRP (materials requirement) system of the factory. The Corporate Quality Division mandated that all sites with links to the US market must conform to the validation policy for MRP systems while other sites (such as Gebze) are recommended to follow the policy.

Following request from the Logistics Director of the company in Turkey the corporate Business Excellence Group from Stockley Park, UK, visited Turkey, carried out a feasibility study and put forward the following recommendations in September 1997:

1. *Changes*
   - Implement a company-wide S&OP process (see Figure 20.2) supported by appropriate training.
   - Re-engineer the MRPII process according to company requirements.
   - Update *MFG-Pro* planning modules to comply with re-engineered MRPII requirements and validation guidelines.
   - Install a performance management process to work towards MRPII Class A standards.
2. *Time scale*
   - *MFG-Pro* will have to be Y2K enabled by the end of 1999.
   - The work on Business Process Excellence and MRPII processes is expected to take 18 months leading to MRPII Class A.
3. *Cost*
   - $50,000 will be available from a corporate fund to ensure the validation on Y2K compliance of *MFG-Pro*.
   - The training, consulting and other costs for the Business Process Excellence project are expected to be self-financing and supported by the company in Turkey.

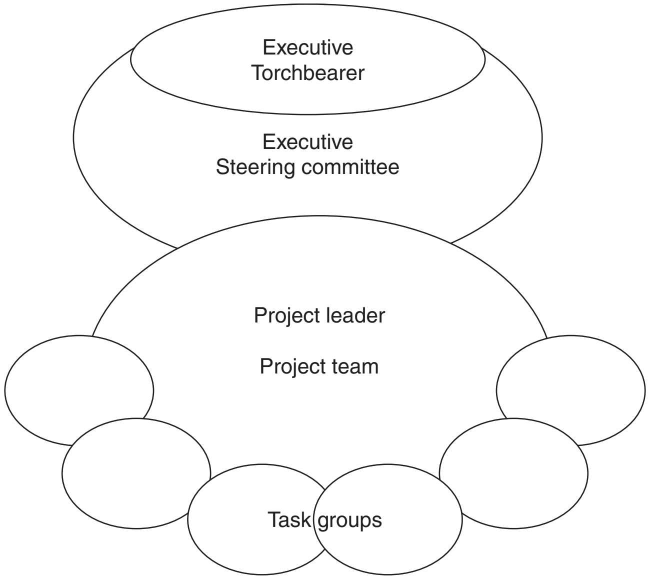

Figure 20.2 Project organization.

Project launch

The company in Turkey launched a programme (known as EKIP) in January 1998 to improve company-wide communications and sustain a robust business planning process using MRPII 'best practice' principles.

The Logistics Director was involved in a MRPII Class A project when he was previously working in Bristol Myer Squibs and was appointed as the Project Manager for EKIP. He invited two consultants from OW Group, who are known to be specialists in MRPII processes to run a 2-day training workshop for manager. The OW consultants advised:

- To set up a project team with specific task groups for S&OP, demand management, production planning, *MFG-Pro* update, quality and validation, performance management, and training and communication.
- To achieve MRPII Class A the company should fulfil performance criteria (e.g. Order Fill 95 per cent, BOM accuracy per cent, MPS performance 95 per cent, supplier delivery performance 95 per cent, inventory record accuracy 99 per cent), MRPII process integrated with the software *MFG-Pro* and a sustainable S&OP process.

The Logistics Director decided that after the OW training workshop the company will do everything themselves except the software support from a local consulting firm to update *MFG-Pro*.

Corporate review

The supply chain problem escalated and Logistics Director had to spend more time in the trouble shooting of day to day operations. In 3 months there were little progress with the EKIP except some Y2K related systems specification for MFG-Pro and the formation of task groups. The relations between the Logistics Team at the head office and the Production Team at Gebze deteriorated further.

A key member of the Corporate Manufacturing and Supply Strategy Group from England reviewed the status of Project EKIP and recommended a full time Project Manager, a revised organization and a road map to Class A for GW Turkey. Logistics Director continued as part of the steering team continued to be a key player in the success of the project.

Implementation

Following the recommendations of the corporate review the first task was to appoint a full time project manager. After considering candidates from Production, Engineering, Logistics, IT, Finance and sister companies a Management Accountant was chosen to lead the project. The primary criteria of selection included project management experience, business knowledge and leadership qualities. With some guidance from Corporate Business Excellence Group a project definition report was prepared as summarized below:

PROJECT EKIP

Project definition report

1.1 *Purpose*

- To install a performance management process to work towards MRPII Class A standards.
- To update the ERP system (MFG-Pro) to comply with validation guidelines, Y2K compliance and re-engineered MRPII requirements.

1.2. *Scope*

The project will include:

- Re-engineering of MRPII process according to company requirements
- A company-wide S&OP process supported by appropriated training
- Updating of MFG-Pro to comply with FDA validation, Y2K and re-engineered planning modules
- Development of a Balanced Scorecard

Excluded from the Scope of Work are:

- Rationalization of factory and warehouse
- Transfer of Head Office

- Corporate Global Supply Chain Project
- Y2K compliance of other legacy systems

1.3 *Objectives*

The project will be executed with minimum disruption to existing business

- MFG-Pro will be updated and Y2K enabled by the end of 1999
- S&OP Process will be operational by September 1998
- MRPII Class A award will be targeted by April 1999
- The employees will receive sustainable training and education to support the process in the longer run

1.4 *Product Breakdown*

The product breakdown structure of Project EKIP comprised:

- S&OP Process
- Demand Management
- Master Production Schedule and Capacity Planning
- Bill of Materials and Procurement
- Manufacturing and Distribution
- Quality Management, Risk/Change Control and Process Validation
- Balanced Scorecard
- Education, Training and Communication
- MFG-Pro Systems

1.5 *Life Cycle*

Project EKIP comprises two streams of project life cycle:

1.5.1 Business Process Excellence

- Definition
  - Project Definition Report
  - Initial Education
  - Project Launch
- Organization
  - Project Organization Structure
  - Project Plan
  - Training
- Implementation
  - S&OP Meetings
  - MRPII re-engineering
  - Balanced Scorecard
  - MFG-Pro Interface
  - Education and Communication

- Closure
  - MRPII Class A Audit
  - Award ceremony

1.5.2 ERP Systems

- Definition
  - Systems functionality
  - Regulatory requirements
  - Y2K requirements
- Organization
  - Systems design
  - Systems customization
  - User training
  - MRPII business process interface
- Implementation
  - Conference Room Piloting
  - Systems Cut-over
  - Validation
- Closure
  - Hand-over
  - Operational Manual
  - Systems support

1.6 *Execution Strategy*

- External Support
  - MFG-Pro development by a local software company
  - S&OP initial training by Oliver Wight
  - Y2K modification by a local software company
  - Two audits and Class A awards by Oliver Wight
- Corporate Support
  - Part of Steering Team
  - Business Process Training
  - Balanced Scorecard development
  - Validation guidelines
- Local Support
  - All other activities
  - Project management
  - Steering Team, Project Team and Task Teams

The project organization (see Figure 20.2) comprised a steering team headed by a 'torch bearer' (Managing Director) and project team led by the Project Manager and a supporting task team. The project team consisted of the Project Manager and leaders from each task team. The steering team members were mostly the company board members and the Project Manager and the Business Excellence Director for the centre. Steering team members also act as 'mentors' of task teams according to their functional responsibilities. The progress of the project was reviewed every week by the project team and every 4–6 weeks by the steering team. The project deliverables were accomplished in time including the Y2K dead line and the development of a Balanced Scorecard. The critical success factors were the total commitment of the top management, continuous education of task teams, robust communication with stakeholders and a good interface between the business requirements and software (*MFG-Pro*).

On going process and sustainability

The achievement of MRPII Class A did set the foundation of continuously improving and sustaining supply chain performance. The key drivers of this process were S&OP meetings supported by Balanced Scorecard and business planning cycle. The company also retained a core team from the project for continuous training of employees and cost effectiveness projects. When the Lean Sigma initiative from the centre was rolled out to the company in Turkey both the core team and the company culture were ready for it. Selected members of the staff were trained as 'black belts' (called Experts) and 'green belts' (called Advocates) and many projects were identified and implemented. Lean Sigma pushed the performance boundaries achieved by Class A and, for example, 95 per cent customer service level was aiming high towards 'perfect orders' with service level of at least 99 per cent. During the consolidation of the merger process there was a temporary lull in Lean Sigma activities for about 3 months and after the re-organization of the programme team the second wave of training and new projects was launched.

The projects in Lean Sigma also included the concept of lean and agile supply chain. The company in Turkey was designated as the supply hub for specific therapeutic product groups for the Middle East and North African market. One such product group is Cefalosporin (antibiotics). The countries in the region had different secondary and tertiary packs and also leaflets in respective languages. The secondary pack sizes were standardized depending on the dose form and lean manufacturing principles were applied and semi-finished products were produced to stock according regulatory shelf life of products. The finished products were scheduled as per confirmed orders from each country of the region and appropriate tertiary packaging and leaflets in country languages were assembled as per order. The average lead time was reduced from 120 days to 27 days.

In the light of FDA recommendations SAP R/3 replaced *MFG-Pro* software after 2 years and the Global Supply Chain system driven by 'Manugistics' was linked with the ERP system of SAP R/3. The company in Turkey was able to participate in the Collaborative Planning Forecasting and Replenishment (CPFR) process with Corporate Manufacturing & Supply in Brentford (UK) and other manufacturing sites in the Global Supply Chain network. The company also established electronic data interchange (EDI) links with a number of key local suppliers. Some key local suppliers were also sometimes included in S&OP meetings by invitation.

The company is also working with the Corporate R&D to incorporate environment, health and safety considerations into the design of new products through EHS (environment, health and safety) staff participation in and support for new product teams, and through the use of the Eco-design Toolkit. EHS involvement in the new product teams also provides a unique opportunity to influence supply chain decisions and highlight systemic EHS issues early in the product development process. The Eco-design Toolkit is available in the corporate intranet and includes a green chemistry and technology guide, a materials guide and a green packaging guide. The company also provides oversight and audit of EHS issues with the support of experts from the centre for critical suppliers and contract manufacturers of materials that are used exclusively by the company.

Terminology

BOM	Bill of Materials
CPFR	Collaborative Planning Forecasting and Replenishment
EHS	Environment, Health and Safety
ERP	Enterprise Resource Planning
FDA	Food and Drug Administration
MPS	Master Production Schedule
MRPII	Manufacturing Resource Planning
OW	Oliver Wight
Y2K	Year 2000

Questions for Total Supply Chain case study

1. Following the slow start of Project EKIP your team has been asked to visit Turkey 3 months after the project launch to review the status of the project and develop your Project Organization. You could consider the following:
   (a) Project organization chart
      – Steering Team
      – Project Team
      – Project Manager
      – Task Teams
   (b) Who should be the Project Manager?
   (c) What are the Task Teams and their deliverables?
   (d) Outline a time plan in a Gantt chart
   (e) Roles of external and internal consultants
2. What are the critical success factors of Project EKIP? Discuss how the success of the EKIP project helped the company in Turkey to improve and sustain supply chain performance.
3. On the basis of your analysis of the total supply chain case study critically review to what extent the company in Turkey fulfilled the best practices of supply chain building blocks with particular reference to:
   – systems and procedure
   – sales and operations planning (S&OP)

– performance management
– lean and agile supply chain
– green supply chain

Beer game case study

The Beer Game is a role-playing simulation developed at MIT in the 1960's to clarify the advantages of taking an integrated approach to managing the supply chain; it particularly demonstrates the value of sharing information across the various supply chain components. This simulation was further illustrated in the concepts of systems thinking and integrated learning organization in Senge's *Fifth Discipline* (1990).

Essentially the beer game is a simplified supply chain consisting of a single retailer, a single wholesaler that supplies the retailer, a single distributor that supplies the wholesaler, and a single factory with unlimited raw materials that supplies the distributor. Each component in the supply chain has unlimited storage capacity, and there is a fixed supply lead time and order delay time between each component. In the beer game each player manages one of the supply chain components. Each week the retailer observes external demand, fills that demand if possible, records backorders to be filled and places an order with the wholesaler. Each of the other components also observes the demand, fills the demand if possible, records the backorder situation and places and order or in the case of the factory schedules production. As a result of a change in external demand the whole supply chain has to react to this change. Order processing and filling delays are built into the simulation, which causes the delay in the system. As a result the players tend to over order especially when in a backlog situation. As a result the system appears to experience widely oscillating demand that is amplified as we move further up the supply chain. Thus inventory and backorder levels usually vary dramatically from week to week during the game. At the end players instinctively blame the other players for causing the situation. What they don't accept is that the system itself was capable of reacting in a way that they did not expect. In effect the beer game demonstrates the phenomenon known as the 'bull whip' effect.

There are various versions and hybrids of beer game in the public domain. Our aim in this case study is to demonstrate with the aid of a simple distribution operation (Charlie's warehouse) how the systems dynamics of supply chain behave in a controlled environment.

Charlie was driving home after a stimulating MBA workshop. The lecturer had begun a session on supply chain management by saying that 'the dynamic nature of the supply chain is evident in the changing nature of the structure of the supply chain and in the day-to-day activities of the players. In a typical supply chain, each participant can create disturbances, either independently or in response to actions taken elsewhere within the supply chain. These disturbances frequently create a chain reaction'. To demonstrate this latter phenomenon the lecturer introduced the workshop members to the 'beer game'. In the game the members were assigned roles and participated in a simulation of a simple production and distribution system.

There is no real beer in the beer game and it does not promote drinking though it generally leads to some robust exchanges between participants. The lecturer observed ‘What is interesting about the beer game is that it has been played so many times yet the patterns of behaviour generated in the game are remarkably similar’.

Charlie pondered on what he had learnt from the analysis and discussion at the end of the game and considered how he could apply this new found knowledge to his own operation.

Charlie’s Operation

Charlie is the Operations Manager of a wholesaler that supplies 50 plus retailers. The products stocked come under the heading of personal hygiene. There is a range of 220 products (line items). Products are received from several distributors and in some cases direct from the manufacturer. There are three main distributors (accounting for 80 per cent of the product lines and about 78 per cent of the demand). There are 20 other distributors plus two factories which supply direct to Charlie. The major distributors are in competition with each other as their products are very similar and in some cases the only perceptible difference is the brand name. Two of the distributors are sourced from the one factory Busby and Co.

There is no seasonal demand by consumers, in fact retailers have advised Charlie that consumer demand is almost constant, that is there is no particular day or month in which demand for any of the products is markedly higher or lower than any other day or month. Although Charlie accepts what the retailers say, but nonetheless he has never been able to understand why the size of orders from retailers fluctuate to the extent that they do. Over a 12-month period the total demand is 52,000, which Charlie would have expected would give an average demand of 1000 per week, but in reality for some weeks retailer’s orders can be as high as 4000 (and this high demand might last for two or even 3 weeks), and in other weeks the demand is almost nothing. Charlie tries to keep sufficient stock on hand so that he can satisfy a retailers order within 2 days. There is a 2-week lead time from the larger distributors, but from the two direct supply factories and some of the smaller distributors the lead time can be up to 4 weeks.

Charlie uses a computerized spreadsheet and records on a daily basis the amount of stock on hand for each line item, the amount received and the date, the amount ordered and the date of order, the amount issued, and the amount of any backorders. From this information the computer automatically:

- Calculates the average past lead time to replenish stock for each line item.
- The average demand calculated from the last 4 weeks demand.
- e-Mails an order on the distributors and the two direct supply factories.

The computer allows 1 week of ‘safety’ stock in its calculation of the amount ordered. For example, one of the largest distributors is XTRA. XTRA are very reliable and when an order is placed on them they will generally supply within 2 weeks. Thus the computer calculates that for a XTRA product, when the stock level drops to the computer's calculation of 3 weeks demand, the computer will automatically trigger an order on XTRA after deducting any stock already on order. The assumption being that the stock will be received from XTRA within 2 weeks and thus the stock level will not drop below the safety level of 1 weeks demand. Similar calculations are made for automatic ordering on all the other distributors and on the two factories that supply directly to Charlie.

A problem occurred 3 months ago when one of the larger distributors POISE Limited announced a price rise. The retailers learnt of the impending price rise before Charlie did, and there was some panic ordering by many of the retailers. As a result Charlie ran out of stock for almost one third of the line items. POISE Limited took 6 weeks to deliver new stock. By then most of the retailers wanted to cancel their back orders.

Due to the fluctuations in order size Charlie finds he has either too much stock or not sufficient stock to meet the desired 2-day turn around of orders. Seldom does he have the desired level of stock for all line items; some will be badly overstocked, and there will be stock outs for other items. Another problem is people. Charlie has 8 warehouse staff. Some days they have little to do, and at other times he has to ask them to work overtime. Staff turnover is high, and new staff make mistakes. There is also some degree of stock 'shrinkage' and Charlie suspects this is due to theft by staff.

Amos the accountant has advised Charlie that bank interest rates have increased and that the landlord is asking for a 15 per cent rent increase. The Accountant has calculated that if Charlie can reduce stock holding by 10 per cent that it will be possible to sub let part of the warehouse and thus reduce overhead costs. The accountant also suggests that Charlie could reduce the number of staff he employs and suggests that the 2-day delivery target to the retailers could be changed to 5 days, Amos adds that 'you are paying too much in overtime'.

Charlie decides to do some calculations. His figures are shown below.

Charlie's Warehouse

Distributor

	XTRA	POISE	JANES	OTHERS	TOTAL
Annual Demand (units)					
	14,000	12,500	15,100	10,400	52,000
Average Delivery lead time (5-day work week)					
	10 days	15 days	12 days	13 days	12.4 days

Stock on Hand (units)

(as at *today*)

1200	100	1900	1600	4800

Total desired maximum stockholding =

5 days ‘safety’ plus 12.4 days re-order = 17.4 days
Total desired minimum stockholding = 5 days
Desired average stockholding = 11.2 days

Questions for the beer game

1. Consider and suggest reasons for the fluctuations in demand for Charlie’s warehouse.
2. Charlie is a customer of the distributors. Consider how Charlie would measure their performance. Compare Charlie’s service requirements to the service he aims to give to his customers, the retailers.

Charlie is only one component of the supply chain. Consider how using shared electronic information could benefit the major members of this supply chain. In your answer consider the benefits and dangers of sharing information with other components of a supply chain, bearing in mind that some components are serious competitors.

Part 4: Integrating supply chain management

Questions

1. Explain the distinctive features of the three dimensions of quality product, process and organization. Discuss and distinguish between the dimensions of quality as presented by Gravin and Parasuraman.
2. Identify from the customer's viewpoint those dimensions of quality in supply chain management which could be important for the following products/services:
   (a) Luxury Cruise Ship
   (b) Medical Centre
   (c) Supermarket Service
   (d) Rolex Watch
   (e) Package Holiday
   (f) Ford Motor Company
   (g) Norwich Union Insurance Company
   (h) Advertising of a Nokia Mobile Phone
3. How would you distinguish between inspection, quality control, quality assurance and total quality management (TQM)?
   What are the appropriate areas or stages of application for each scheme in supply chain management?
   What does 'total' mean in TQM?
4. What are the features and philosophy common to both TQM and Six Sigma?
   Explain the new features, if any, in a Six Sigma programme.
   What are the additional features in Lean Sigma and FIT SIGMA?
5. Explain the various elements of the 'cost of poor quality'.
   Why is it that some quality-related costs, after the delivery of goods, are more significant to the supplier?
   List the key elements of the internal and external failure costs in your organization.
6. What are the major software systems to manage total supply chain management? Discuss how the shifts of technology platforms have increased the effectiveness of supply chain software systems.

7. Discuss the relative advantages of a 'best of breed approach' and a 'single integrator approach' to implement supply chain ICT (information and communication technology) systems. What type of industries would be most likely to select which approach and why?
8. What are the critical success factors of implementing an ERP system in a FMCG (fast-moving consumer goods) multinational company? Recommend the key steps of implementation.
9. A manufacturer of disk brake components has a full order book and adequate manufacturing capacity. However customer service is unsatisfactory as shown by the average order fill efficiency for the current year of only 82 per cent.

   Explain how the S&OP technique can set up a process to improve the order fill efficiency.
10. A major European logistics business employing over 10,000 staff and operating in ten countries wishes to implement a performance management system based on the principles of the Balanced Scorecard. What are the key performance indicators (not more than 10) that you would recommend? Outline the key steps for implementing the Balanced Scorecard.
11. The EFQM Excellence model enables an organization to carry out periodic self assessments and review its business processes and results. Show how you would use the model and methodology in;
    (a) continuous self assessment in a multi-site manufacturing company.
    (b) establishing best practices in a government department
    (c) monitoring the progress of a Six Sigma programme in a multinational organization containing both manufacturing and service operations.
12. A privatized national carrier implemented ISO 9000:2000 in selected departments. The management of the organization is considering the next step to roll out EFQM (European Foundation of Quality Management) in all departments. Explain how you would implement the transition and roll out.
13. You are a management consultant with particular expertise in the continuous improvement of all types of business. Recommend the appropriate tools for improving the performance of the following operations:
    (a) A small insurance company
    (b) The production line of a medium sized manufacturing company
    (c) A large multinational pharmaceutical company
    (d) A high street bank
14. Following the slow start of Project EKIP your team has been asked to visit Turkey 3 months after the project launch to review the status of the project and develop your Project Organization. You could consider the following:
    (a) Project Organization chart
        – Steering Team
        – Project Team
        – Project Manager
        – Task Teams

(b) Who should be the Project Manager?
(c) What are the Task Teams and their deliverables?
(d) Outline a time plan in a Gantt chart
(e) Roles of external and internal consultants

15. What are the critical success factors of the EKIP project? Discuss how the success of the EKIP project helped the company in Turkey to improve and sustain supply chain performance.
16. On the basis of your analysis of the total supply chain case study critically review to what extent did the company in Turkey fulfil the best practices of supply chain building blocks with particular reference to:
    - systems and procedure
    - sales and operations planning (S&OP)
    - performance management
    - lean and agile supply chain
    - green supply chain
17. What is the 'bullwhip effect' in supply chain management? What are the key factors contributing to the 'bullwhip effect' and how would you reduce their impact? Explain how the simulations on the 'beer game' can help assess the impact of forecast errors contributing to the 'bullwhip effect'.

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Glossary

ABC analysis It is based on a Pareto analysis grouping units usually according to the share of annual cost. Units having 80 per cent annual cost are considered in the 'A' classification, units with the bottom 5 per cent share are 'C' items and units with costs in between are in the 'B' category.

Activity-based costing It is analysing the cost of an operation at each processing step. In addition to measuring direct costs it covers bottlenecks, delays, and other time-related activities to highlight areas of inefficiencies in an operation.

Activity network diagram It is a network analysis technique to allow a team to find the most efficient path and realistic schedule of a project by graphically showing the completion time and sequence of each task.

Balanced Scorecard Balanced Scorecard introduced by R. Kaplan and D. Norton in early 1990s is a concept for measuring a company's activities in terms of its vision and strategies, to give managers a comprehensive view of the performance of a business. Typically it comprises simple tables broken into four sections of 'perspectives' which are labelled as 'Financial', 'Customer', 'Internal Business Processes' and 'Learning & Growth'.

Bar chart It is also known as Gantt chart, indicates scheduling activities. Horizontal bars show the various activities with the length of the bar proportional to the duration of a particular activity.

Benchmarking It is rating an organization's products, processes and performances with other organizations in the same or another business. The objective is to identify the gaps with competitors and the areas for improvement.

Best practice Best practice refers to any organization that performs as well or better than the competition in quality, timeliness, flexibility and innovation. Best practice should lead to world class performance.

Black belts They are experts in Six Sigma methods and tools. Tools include statistical analysis. Black belts are project leaders for Six Sigma initiatives, they also train other staff members in Six Sigma techniques.

Brainstorming A freewheeling group session for generating ideas. Typically a group meeting of about seven people will be presented with a problem. Each member will be encouraged to make suggestions without fear of criticism. One suggestion will lead to another. All suggestions, no matter how seemingly fanciful, are recorded and subsequently analysed. Brainstorming is useful for generating ideas for further detailed analysis.

Business process re-engineering (BPR) It has been described as a manifesto for revolution. The approach is similar to taking a clean piece of paper and starting all over by identifying what is really needed to make the mission of the organization happen.

Capability Maturity Model Integration (CMMI) It is a process improvement approach that provides organizations with the essential elements of effective processes. It was developed by the SEI (Software Engineering Institute) at Carnegie Mellon University in Pittsburgh.

Capacity planning Capacity planning specifies the level of resources (e.g. facilities, fleets, equipment, systems hardware and labour force size) that best supports the enterprise's competitive strategy for production.

Capacity requirement planning (CRP) It is a computerized technique to predict resource requirements of all available workstations (also see RCCP). RCCP balances workloads at a high level, CRP will then fine tune the workload balance.

Carbon offset It is the process of reducing the net carbon emissions of an individual or organization, either by their own actions or through arrangements with a carbon-offset provider.

Cause and effect diagram The cause and effect, fishbone or Ishikawa diagram was developed by Kaoru Ishikawa. The premise is that generally when a problem occurs the effect is very obvious, and the temptation is to treat the effect. With the Ishikawa approach the causes of the effect are sought. Once the cause is known and eliminated the effect will not be seen again. For example, working overtime is an effect, adding extra staff does not remove the cause. The question is what caused the situation that led to overtime being worked.

Collaborative Planning Forecasting and Replenishment (CPFR) Data and process model standards are developed for collaboration between suppliers and an enterprise with prescribed methods for planning (agreement between the trading partners to conduct business in a certain way); forecasting (agreed-to methods, technology and timing for sales, promotions and order forecasting) and replenishment (order generation and order fulfilment).

Continuous improvement It is always looking for ways to improve a process or a product, but not necessarily making radical step changes. If the basic idea is sound, then building on it will improve quality. In Japan this is known as Kaizen.

Control chart It is a tool in statistical process control to monitor the number of defects found in a product or a process overtime and study the variation and its source.

Cost of poor quality (COPQ) The cost of poor quality is made up of costs arising from internal failures, external failures, appraisal, prevention and lost opportunity costs. In other words all the costs that arise from non-conformance to a standard.

CTQs In Six Sigma CTQs are referred as critical to quality. This simply means the identification of factors that are critical for the achievement of a level of quality.

Customer relationship management (CRM) It is the development of the database and strategies necessary to have the maximum client relationships in terms of quality, cost, reliability and responsiveness.

Cycle time It is the elapsed time between two successive operations or the time required to complete an operation.

Demand forecast It is the prediction, projection or estimation of expected demand over a specified future time period.

Design for Six Sigma (DFSS) See Basu (2004), pp 174–179 for detailed discussion. The steps are define, measure, analyse, design and validate.

Distribution channels The selling channels supported by an enterprise. These may include retail sales, distribution partner (e.g. wholesale) sales, original equipment manufacturer (OEM) sales, Internet exchange or marketplace sales and Internet auction or reverse auctions sales.

Distribution requirements planning (DRP) Process for determining inventory requirements in a multiple plant/warehouse environment. DRP may be used for both distribution and manufacturing. In manufacturing, DRP will work directly with MRP. DRP may also be defined as distribution resource planning which also includes determining labour, equipment and warehouse space requirements. DRP is the planning step in the supply chain to move finished goods from production or stock to the customer.

DMAIC It is the cycle of define, measure, analyse, improve and control, see Basu (2004), pp 168–174 for detailed discussion.

e-Business Electronic-business is more than the transfer of information using information technology. e-Business is the complex mix of processes, applications and organizational structures.

Ecosystem It is a natural unit consisting of all plants, animals and micro organisms in an area functioning together. The community of internet user groups is also known as digital ecosystem.

Enterprise resource planning (ERP) It is the extension of MRPII systems to the management of complete business functions including finance and human resources.

European Foundation for Quality Management (EFQM) It is derived from the American Malcom Baldridge Quality award. It is an award for organizations that achieve world class performance as judged by independent auditors against a checklist. The checklist is detailed and extensive and covers: leadership, people management, policy and strategy, partnerships and resource, processes, people satisfaction, customer satisfaction, impact on society and business results.

Five Ss These represent a set of Japanese words for excellent house keeping (Sein – Sort, Seiton – Set in place, Seiso – Shine, Seiketso – Standardize, and Sitsuke – Sustain).

Fishbone diagram The fishbone, Ishikawa, or cause and effect diagram was developed by Kaoru Ishikawa. The premise is that generally when a problem occurs the effect is very obvious, and the temptation is to treat the effect. With the Ishikawa approach the causes of the effect are sought. Once the cause is known and eliminated the effect will not be seen again. For example, working overtime is an effect, adding extra staff does not remove the cause. The question is what caused the situation that led to overtime being worked.

FIT SIGMA Also see TQM, Six Sigma and Lean Sigma. FIT SIGMA incorporates all the advantages and tools of TQM, Six Sigma and Lean Sigma. The aim is to get an organization healthy (fit) by using appropriate tools for the size and nature of the business (fitness for purpose) and to sustain a level of fitness. FIT SIGMA is a holistic approach.

Flow process chart A flow process chart that sets out the sequence of the flow of a product or a procedure by recording all the activities in a process. The chart can be used to identify steps in the process, value adding activities and non-value adding activities.

Forecasting process A forecasting process provides a mechanism for soliciting participation from individuals who have knowledge of future events and compiling it into a consistent format to develop a forecast. The forecasting process concentrates defining how information will be gathered and reconciled into a consistent picture of the future. In cases where a statistical forecast is used, the process will also define how much weight should be given to the mathematical models versus input from participants to develop the final consensus forecast.

Gantt chart See Bar chart.

Green belts They are staff trained to be Six Sigma project leaders, they work under the guidance of black belts (see Black belts).

Greening the supply chain It refers to buyer companies requiring a certain level of environmental responsibility in core business practices of their suppliers and vendors.

Input process output diagram All operations or processes have inputs and outputs. The process is the conversion of inputs into outputs. Analysis of inputs should be made to determine factors that influence the process, for example input materials from suppliers meeting specification, delivery on time and so on.

Inventory management The process of ensuring the availability of products through inventory administration activities such as demand planning, stock optimization and monitoring the age of the product.

Ishikawa The Ishikawa, or fishbone, or cause and effect diagram was developed by Kaoru Ishikawa. The premise is that generally when a problem occurs the effect is very obvious, and the temptation is to treat the effect. With the Ishikawa approach the causes of the effect are sought. Once the cause is known and eliminated the effect will not be seen again. For example, working overtime is an effect, adding extra staff does not remove the cause. The question should be why is overtime necessary and what caused this problem.

ISO 9000 To gain ISO 9000 accreditation an organization has to demonstrate to an accredited auditor that they have a well-documented standard and consistent process in place which achieves a defined level of quality or performance. ISO accreditation will give a customer confidence that the product or service provided will meet certain specified standards of performance and that the product or service will always be consistent with the documented standards.

Just-in-time (JIT) It was initially a manufacturing approach where materials are ordered to arrive just when required in the process, no output or buffer stocks are held, and the finished product is delivered direct to the customer. Lean Sigma incorporates the principals of JIT and now relates to the supply chain from supplier and supplier's supplier, through the process to the customer and the customer's customer.

Kaizen It is a Japanese word derived from a philosophy of gradual day-by-day betterment of life and spiritual enlightenment. This approach has been adopted in industry and means gradual and unending improvement in efficiency and/or customer satisfaction. The philosophy is doing little things better so as to achieve a long-term objective.

Kanban It is a Japanese word for card. The basic kanban system is to use cards to trigger movements of materials between operations in production so that a customer order flows through the system. Computer systems eliminate the need for cards but the principle is the same. As a job flows through the factory, completion of one stage of production triggers the next so that there is no idle time, or queues, between operations. Any one job can be tracked to determine the stage of production. A 'Kanban' is raised for each customer order. The kanban system enables production to be in batches of one.

Key performance indicators (KPIs) It includes measurement of performance such as asset utilization, customer satisfaction, cycle time from order to delivery, inventory turnover, operations costs, productivity and financial results (return on assets and return on investment).

Lean Sigma Also see Just-in-time (JIT). Lean was initially a manufacturing approach where materials are ordered to arrive just when required in the process, no output or buffer stocks are held, and the finished product is delivered direct to the customer. Lean Sigma incorporates the principals of Six Sigma, and is related to the supply chain from supplier and supplier's supplier, through the process to the customer and the customer's customer.

Manufacturing resource planning (MRPII) It is an integrated computer-based procedure for dealing with all of the planning and scheduling activities for manufacturing, and includes procedures for stock re-order, purchasing, inventory records, cost accounting and plant maintenance.

Master Production Schedule It (also commonly referred to as the MPS) is effectively the plan that the company has developed for production, staffing, inventory, etc. MPS translates your business plan, including forecasted demand, into a production plan using planned orders in a true multi-level optional component scheduling environment. Using MPS helps you avoid shortages, costly expediting, last minute scheduling and inefficient allocation of resources.

Materials requirement planning (MRP) It is a dependent demand system that calculates materials requirements and production plans to satisfy known and forecast sales orders. MRP helps to calculate volume and timing requirements to meet an estimate of future demand. There are three major types of computer-based MRP systems – MRPI, 'Closed loop' MRP and MRPII.

Mind mapping It is a learning tool for ordering and structuring the thinking process of an individual or team working on a focused theme. According to Buzan the Mind Map 'harnesses the full range of cortical skills – word, image, number, logic, rhythm, colour and spatial awareness – in a single and uniquely powerful technique'.

Monte Carlo technique It is a simulation process. It uses random numbers as an approach to model the waiting times and queue lengths and also to examine the overall uncertainty in projects.

Mudas Muda is the Japanese word for waste or non-value adding. The seven activities that considered are excess production, waiting, conveyance, motion, process, inventory and defects. For further detail see Chapter 13.

Overall equipment effectiveness (OEE) It is the real output of a machine. It is given by the ratio of the good output and the maximum output of the machine for the time it is planned to operate.

Pareto Wilfredo Pareto was a 19th century Italian economist who observed that 80 per cent of the wealth was held by 20 per cent of the population. The same phenomenon can often be found in quality problems. Juran (1988) refers to the vital few and the trivial many. The technique involves collecting data of defects, identifying which occur the most and which result in the most cost or damage. Just because one defect occurs more often than others does not mean it is the costliest or should be corrected first.

PDCA The Plan-Do-Check-Act cycle was developed by Dr W.E. Deming. It refers to Planning the change and setting standards, Doing – making the change happen, Checking that what is happening is what was intended (standards are being met) and Act – taking action to correct back to the standard.

PESTLE Political, Economic, Social, Technical, Legal and Environmental, is an analytical tool for assessing the impact of external contexts on a project or a major operation and also the impact of a project on its external contexts. There are several possible contexts including political, economic, social, technical, legal and environmental.

Poka Yoke Refers to making each step of production mistake free. This is known as mistake proofing. Poka Yoke was developed by Shingo, also see SMED, and has two main steps: (1) preventing the occurrence of a defect and (2) detecting the defect. The system is applied at three points in a process:

1. In the event of an error, prevent the start of a process.
2. Prevent a non-conforming part from leaving a process.
3. Prevent a non-conforming product from being padded to the next process.

Project A project is a unique item of work for which there is a financial budget and a defined schedule.

Project charter It is a working document for defining the terms of reference of each Six Sigma project. The charter can make a successful project by specifying necessary resources and boundaries that will in turn ensure success.

Project management It involves the planning, scheduling, budgeting and control of a project using an integrated team of workers and specialists.

Process mapping It is a tool to represent a process by a diagram containing a series of linked tasks or activities which produce an output.

Quality circles Quality circles are teams of staff who are volunteers. The team selects issues or areas to investigate for improvement. To work properly teams have to be trained, first in how to work as a team (group dynamics) and secondly in problem solving techniques.

Quality function deployment (QFD) It is a systematic approach of determining customer needs and designing the product or service so that it meets the customers needs first time and every time.

Regression analysis It is a tool to establish the 'best fit' linear relationship between two variables. The knowledge provided by the scatter diagram is enhanced with the use of regression.

Resource utilization and customer service (RU/CS) analysis It is a simple tool to establish the relative importance of the key parameters of both resource utilization and customer service and to identify their conflicts.

Rolled throughput yield (RTY) It is also known first pass yield (FPY). It is the ratio of the number of completely defects free without any kind of rework during the process units at the end of a process and the total number of units at the start of a process. The theoretical throughput rate is often regarded as the number of units at the start of the process. RTY/FPY is used as a key performance indicator to measure overall process effectiveness.

Rough-cut capacity planning (RCCP) RCCP process considers only the critical work centres (bottlenecks, highly utilized resources, etc.) and attempts to balance longer-term workloads and demand at high level.

Sales and operations planning (S&OP) It is derived from MRP and includes new product planning, demand planning, supply review, to provide weekly and daily manufacturing schedules and financial information. Also see MRPII. S&OP is further explained in Chapter 18 (see Figure 18.2).

Scatter diagram These diagrams are used to examine the relationship between two variables. Changes are made to each and the results of changes are plotted on a graph to determine cause and effect.

Sigma Sigma is the sign used for standard deviation from the arithmetic mean. If a normal distribution curve exists one sigma represents one standard deviation either side of the mean and accounts for 68.27 per cent of the population. This is more fully explained in Chapter 17.

Signature of quality (SoQ) It is a self-assessment process supported by a checklist covering: customer focus, innovation, personnel and organizational leadership, use of technology and environment and safety issues. It is useful in FIT SIGMA for establishing a company 'health' report.

Single minute exchange of dies (SMED) This was developed for the Japanese automobile industry by Shigeo Shingo in the 1980s and involves the reduction of change over of production by intensive workstudy to determine in process and out process activities and then systematically improving the planning, tooling and operations of the change over process. Shingo believed in looking for simple solutions rather relying on technology.

SIPOC It is a high level map of a process to view how a company goes about satisfying a particular customer requirement in the overall supply chain. SIPOC stands for supplier, input, process, output and customer.

Six Sigma It is a quality system which in effect aims for zero defects. Six Sigma in statistical terms means six deviations from the arithmetic mean. This equates to 99.99966 per cent of the total population, or 3.4 defects per million opportunities.

Statistical process control (SPC) It uses statistical sampling to determine if the outputs of a stage or stages of a process are conforming to a standard. Upper and lower limits are set, and sampling is used to determine if the process is operating within the defined limits.

Supply Chain Operations Reference model (SCOR®) It is a process reference model that has been developed and endorsed by the Supply Chain Council as the cross-industry standard diagnostic tool for supply chain management.

SWOT (strengths, weaknesses, opportunities and threats) It is a tool for analysing an organization's competitive position in relation to its competitors.

The seven wastes Also see muda. Muda is the Japanese word for waste or non-value adding. The seven activities that considered are excess production, waiting, conveyance, motion, process, inventory and defects. For further detail see Chapter 13.

Total productive maintenance (TPM) It requires factory management to improve asset utilization by the systematic study and elimination of major obstacles – known as the 'six big losses' – to efficiency. The 'six big losses' in manufacturing are breakdown, set up and adjustment, minor stoppages, reduced speed, quality defects, and start up and shut down.

Total quality management (TQM) It is not a system, it is a philosophy embracing the total culture of an organization. TQM goes far beyond conformance to a standard, it requires a culture where every member of the organization believes that not a single day should go by without the organization in some way improving its efficiency and/or improving customer satisfaction.

Value analysis It is very often a practice in purchasing, is the evaluation of the expected performance of a product relative to its price.

Value chain It is also known as Porter's value chain, according to Michael Porter the competitive advantage of a company can be assessed only by seeing the company as a total system. This 'total system' comprises both primary and secondary activities.

Value stream mapping (VSM) It is a visual illustration of all activities required to bring a product through the main flow, from raw material to the stage of reaching the customer.

Vendor-managed inventory (VMI) In the VMI process, the vendor assumes responsibility for managing the *replenishment* of stock. Rather than a customer submitting orders, the vendor will replenish stock as needed. This process is sometimes referred to as supplier-managed inventory (SMI) or co-managed inventory.

World class World class is the term used to describe any organization that is making rapid and continuous improvement in performance and who is considered to be using 'best practice' to achieve world class standards.

Zero defects Philip Crosby made this term popular in the late 1970s. The approach is right thing, right time, right place and every time. The assumption is that it is cheaper to do things right the first time.

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