1 A systems view of business

OVERVIEW

This textbook develops models for various aspects of business and operations management. In order to illustrate how the activities of a typical manufacturing business are interrelated, a systems approach is now presented. The systems approach provides an overall view of an organisation's activities whereby an organisation is separated into identifiable subsystems or departments. All such departments are interdependent and perform specific tasks of work which contribute to the organisation's goals. The simplest model of a business system consists of three basic elements, namely inputs, processes, and outputs (Figure 1.1). Output information is used as a control mechanism – normally called a feedback loop – to correct deviations from planned performance.

For example, consider a bakery. The inputs consist of the raw materials that are used to make bread, namely flour, yeast, and water. The actual process is the baking, performed in an oven in which the ingredients are converted into outputs, i.e., bread. In this case, the process is controlled by monitoring the oven's output, i.e., temperature. A temperature feedback loop thus ensures that the correct baking conditions are maintained.

Outputs can be either finished goods or services. A manufacturing business produces a tangible output such as a car or furniture whereas service-orientated businesses, e.g., a bank or hospital, are more customer focused. Generally, service operations use more labour and less equipment than manufacturing. The word 'throughput' is sometimes used to refer to items that are still in the process stage and have not yet been converted into finished goods.

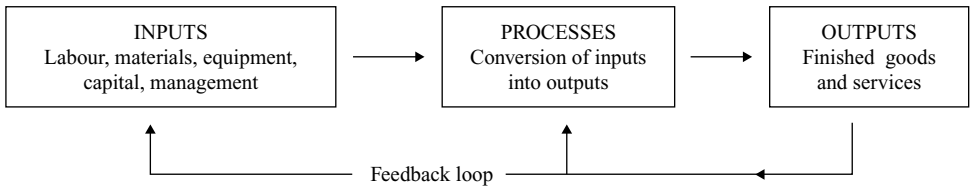

Figure 1.1 Systems view of business.

A SYSTEMS VIEW OF BUSINESS OPERATIONS

In most organisations, departments are formed by grouping similar functions together. While all organisations do not have the same functions, one common approach to functional organisation is to have four main divisions, namely human resources, marketing, finance/accounting and production. Within each of these four divisions, there are further functional subsystems or departments, creating a hierarchical structure as shown in Figure 1.2. In this textbook, the term 'business management' is interpreted in the wider sense of covering all four divisional areas while 'operations management' is concerned specifically with the activities of the production division.

The human resources division deals with the human aspects of an organisation such as labour relations, the work environment, and in-house training. Because personnel activities are people-orientated, the human resources division use computers chiefly as information-retrieval systems, utilising records which are stored in a database. Mathematical applications relating to personnel actions are restricted here to staff planning models in marketing.

The objectives of the marketing division are twofold (i) to identify and (ii) to satisfy customer needs – at a profit to the organisation. In other words, the marketing division not only helps to sell profitably what the production division produces but it also helps to determine what those products should be. Market research is used to identify what consumers actually want, including their preferences and behaviour patterns. The product development department then translates these consumer preferences into general specifications for a new or modified product. At a later stage, the general specifications are refined into detailed product design by the production division. Product development is an example of an interfacing activity requiring input from both marketing and production. Other marketing subsystems which contribute to customer sales are sales forecasting, advertising, salesforce allocation and scheduling, and product pricing.

Because the finance/accounting function focuses on the organisation's economic well-being, accounting activities extend into all business operations. Financial accounting provides economic information for managerial decision-making within the company. Strategic and

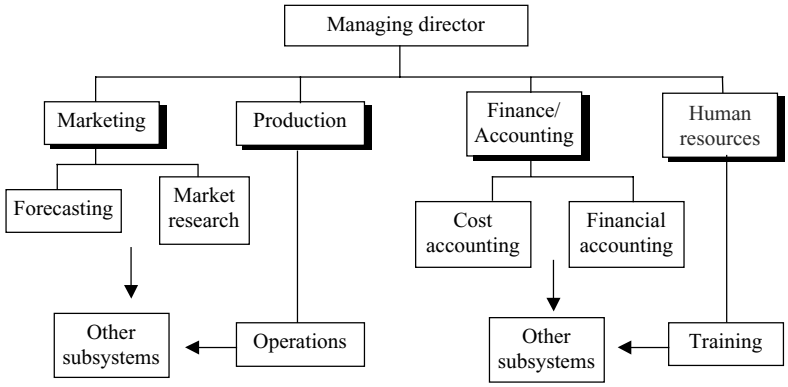

Figure 1.2 Typical functional organisation of a manufacturing business.

operational planning, performance measurement and control, and product costing are common accounting functions that must be performed by management. Another important aspect of managerial control is budgeting. Budgeting is the practical outcome of business planning and is used to ensure that expenditure does not exceed income, i.e., to ensure that the company makes a profit.

The main objective of the production division is to convert raw materials into finished goods. The first step in the manufacturing process is to decide what is to be made and when it is needed. After customer requirements have been established, a product is then designed. This product may be a modification of an existing product or it may be completely new. The resources required to manufacture the product are specified and, where appropriate, the necessary amounts quantified. These resources include raw materials and spare parts, labour, and production facilities.

After the product design and manufacturing processes are determined, the product must be scheduled along with any other products made by the organisation. An effective production schedule is a vital element of production operations. It involves checking production capacity, i.e., is there sufficient labour and materials available, is machine capacity adequate to perform the job, etc.? Having established that there is adequate capacity, the next step is to order the necessary raw materials and parts. Machines and personnel are then scheduled to perform the necessary manufacturing steps. During certain stages of production, the product is examined and compared to its design specifications for performance and quality, i.e., quality control is performed. If the finished product meets all the original design specifications, it is shipped directly to the customer or stored in the warehouse.

A MANUFACTURING BUSINESS MODEL

The interrelationships between the various business functions outlined above can be better understood by examining a model of a manufacturing organisation. The model of Figure 1.3 is not a mathematical model, but a diagram showing the basic data flows between the main subsystems in the organisation. The shaded area contains the key subsystems within the production division.

FINANCE AND COST ACCOUNTING

The two main categories of accounting are financial accounting and management or cost accounting. The terms ‘management accounting’ and ‘cost accounting’ are often used interchangeably. Strictly speaking, cost accounting refers to a manufacturing business, and focuses on the costs of raw materials, labour, and overhead expenses incurred in the production of finished goods. Management accounting is a more generic term referring to the managerial functions of organisational planning and control. Performance measurement and control, product costing, and purchasing decisions are common managerial accounting functions that must be performed by a company’s management.

The finance function covers both financial accounting and financial management. Financial accounting is concerned primarily with providing information for parties external to the

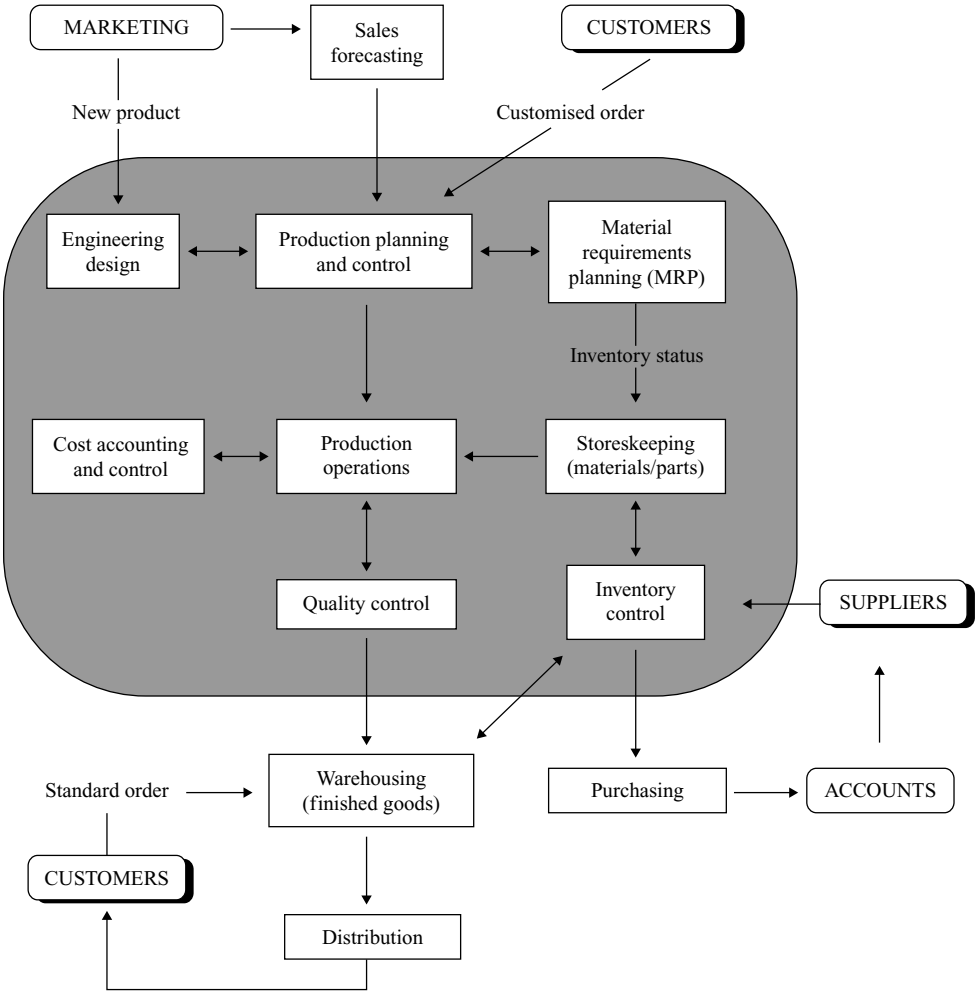

Figure 1.3 Manufacturing business model.

business such as investors, banking institutions and government agencies. If a company wants to borrow money, it must provide the lending institutions with information to show that the company is a sound investment. Likewise, shareholders want to see financial statements indicating how well the company is doing and how much their investment is worth!

The objective of financial management is twofold (i) to ensure that there are sufficient funds available to meet the organisation's financial obligations and (ii) to maximise the returns on invested funds that are not needed to meet current commitments. In order to maximise profit, financial managers must decide whether the benefits accruing from any investment are sufficient to justify the original outlay. Investment situations include capital budgeting decisions relating to expansion plans or new product development, and long-term investments such as government bonds or shares in other companies.

One important aspect of managerial control is budgeting. A budget is a plan – usually expressed in monetary terms – covering a fixed period of time, e.g. one year. It shows the activities that the company intends to undertake in order to achieve its profit goal. While the budget provides projected data, the cost accounting subsystem produces actual data. Variances from set targets are found by comparing actual costs with budgeted or standard costs. For example, a negative or unfavourable variance occurs if actual production uses materials that are more costly than planned. On the other hand, if actual labour hours used in the manufacture of a product are less than budgeted figures, then a positive or favourable variance results.

THE MARKETING FUNCTION

The marketing function utilises a considerable amount of qualitative information which introduces uncertainty into the decision-making process. Qualitative decisions that must be taken by marketing managers include anticipating customer needs, forecasting product sales, and evaluating new sources of competition. Decision-makers often use spreadsheet models as a quantitative tool to obtain answers to various 'what-if' questions. When managers are able to see the immediate effect of changes to sensitive parameters such as sales volume or product price, they are better placed to evaluate feasible alternatives. Because models provide valuable help in performing such sensitive analysis, they are often called decision support systems (DSS).

No organisation can function effectively without a forecast for the goods or services which it provides. A key objective of the marketing division is to produce sales forecasts. Since the projections of sales volumes for future periods often form the basis of organisational objectives, their accuracy is of vital concern. Many statistical models have been developed in an effort to improve forecasting accuracy, including regression-based models, the moving-average method, and exponential smoothing techniques.

Production may be initiated on the basis of either sales forecasts or firm customer orders. Goods that are produced on the basis of a forecasted demand use a product-orientated strategy which involves the continuous production of a standardised product such as glass, paper, cement, and steel. Companies that manufacture the same high-volume standardised product each day are in a position to set standards and maintain a given quality.

Some customer orders are for one-off items which involve the production of customised products, in which case a process-orientated strategy is used. An organisation which uses a process-orientated strategy produces low-volume, high-variety products. The production facilities must have a high degree of flexibility in order to handle the frequent process changes that are required to produce different items. Maintaining standards in such a rapidly changing process environment is much more difficult than in a standardised product-orientated business.

THE PRODUCTION FUNCTION

The main purpose of the production function is to transform raw materials into finished goods. The manufacturing process covers the full life-cycle of a product from its inception to completion. Important decisions must be taken on what items to produce, how to design and

manufacture them, which raw materials will be required, and how best to ensure that the products meet specified quality and performance. The following sections summarise the essential production subsystems.

Production Planning and Control

Production planning determines how many items to produce, when to produce them, and what facilities are required to produce them. The amount of production is determined by (i) sales forecasts and (ii) specific customer orders. The timing of production depends on (i) availability of labour and materials required for the job and (ii) estimated times required to perform production operations. The production facilities required to manufacture the item are prescribed by the design specifications.

A key output from production planning is the master production schedule (MPS) which shows how many items must be produced and when they will be produced in order to meet customer demands. Because the MPS is based on customer orders and forecasts provided by the marketing division, it is an important link between marketing and production. It shows when incoming sales orders can be scheduled for production operations and when finished goods can be scheduled for delivery. The MPS also provides important inputs to the material requirements planning (MRP) system, which is discussed below.

Before an MPS can be developed, estimates of the amounts of each resource needed to meet MPS requirements must be calculated. A production schedule is therefore dictated by the resource constraints on materials and labour availability, machine capacity, and the production time pattern. Effective capacity planning will indicate whether a proposed production schedule is feasible or not. Inadequate machine capacity could rule out a proposed schedule, or overtime may be necessary to overcome personnel limitations.

Production control involves the co-ordination of three main activities, namely, (i) dispatching, i.e., scheduling which machines and operators will perform which steps in the manufacturing process for each item (ii) monitoring actual operations, and (iii) taking corrective actions when and where necessary.

Material Requirements Planning (MRP)

In manufacturing situations, there is usually an inventory of components (or raw materials) which are used solely in the production of finished products. Since there is no outside demand for this inventory, there is no sense in stocking it until it is needed in production operations. The two main objectives of material requirements planning (MRP) are (i) to reduce order-processing delays by ensuring that materials and parts are available when required for production operations and (ii) reduce inventories and their associated costs by holding only those components and items that are really needed. MRP thus combines two of the most important activities in the manufacturing process, namely, production scheduling and materials control.

MRP is a system for managing inventories by anticipating their use. It helps to reduce inventory levels by quickly determining how much materials/components to order and when those orders should be placed. MRP is most appropriate where a company manufactures many

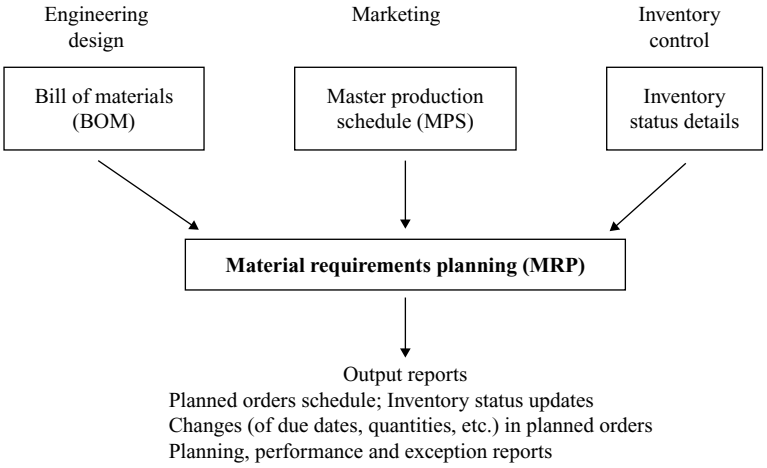

Figure 1.4 Basic input to an MRP system.

products and where product demand is variable. For example, a company may manufacture 100 different items each requiring many components and materials in its assembly. An MRP system must be able to calculate the materials/parts requirements for all 100 items over a fixed period. However, much of the materials and components will be common to many of the items. The MRP system aggregates gross requirements across all the items in order to determine what exactly to order. An MRP system has three major inputs – the master production schedule (MPS), the bill of materials (BOM) and inventory status details – as shown in Figure 1.4.

The master production schedule (MPS) which is discussed in the production planning section above, provides input details of what finished goods are required and when they are needed. The bill of materials (BOM) is a design document listing all of the materials, components, and assemblies/subassemblies needed to make a finished product.

The BOM is developed by the engineering design department and is based on product specifications provided by the marketing division. It not only gives details of a product's components but also shows how it is assembled and how many of each component is required. The primary MRP input from the BOM is the product's structure tree, which depicts the hierarchical levels of subassemblies and components required to make the product, as shown in the bicycle structure tree (Figure 1.5). The structure tree shows three hierarchical levels with bracketed numbers indicating the number of assemblies and components required to make one item on the level above. For example, 50 level-2 spokes are required to make one level-1 wheel assembly, while two wheel assemblies are required in the manufacture of one level-0 bicycle.

The third MRP input, namely inventory status details, gives full and up-to-date information on each inventory item, including quantities on hand, gross requirements, how much has been ordered, safety stock levels, etc. These inventory records also contain details of each component's *lead time*, i.e., the amount of time taken between placing an order and getting the item in stock ready for use. Lead times are a continuous source of uncertainty due to the many activities involved, including timing of order placement, item availability, transportation difficulties, quality control, etc.

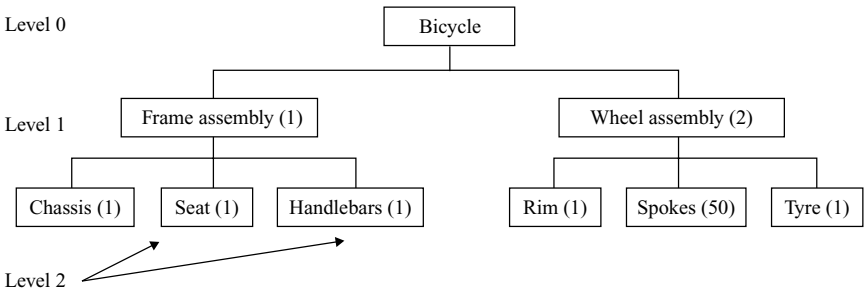

Figure 1.5 BOM product structure tree.

Purchasing

A considerable amount of managerial effort goes into ensuring that the right materials are directed to the right place at the right time and at the right cost. Managing materials in such an effective way is not easy. In a manufacturing environment, materials management involves co-ordinating the activities of three interrelated areas, namely materials purchasing, inventory planning and control, and the delivery/inspection system. The purpose of materials management is to increase the efficiency of production operations by integrating all material acquisition, movement, and storage activities within the company.

Traditionally, the purchasing function was concerned solely with drawing up a list of reliable suppliers and then using a 'lowest cost' criterion to choose the best supplier. However, this narrow view of buying materials at lowest cost represents only one aspect of purchasing management. Nowadays, there is more emphasis on developing a satisfactory supplier-buyer relationship whereby the sharing and exchanging of ideas can benefit both sides. The competitive advantages to be gained from purchasing depend upon both parties working closely together to identify mutual interests. For example, suppliers can use their knowledge of what is available in the market-place to suggest substitute materials that are cheaper or more reliable than those currently being purchased by an organisation.

The importance of having a mutual understanding between suppliers and purchasers is highlighted in the popular 'just-in-time' (JIT) approach to materials purchasing. The JIT philosophy of purchasing items from suppliers just when they are required, reduces – and in some cases eliminates – inventories. Most companies appreciate that capital can be wastefully tied up in inventories which sit around gathering dust. The JIT approach is seen as a way to eliminate such waste by synchronising manufacturing processes and reducing inventory holding costs. However, for JIT to be successful, purchasing management must have confidence that their suppliers can deliver materials in the required amount and at the right time. Any delay in the supply would cause serious production problems – hence the need for a mutual value-added relationship!

The activities of receiving, inspecting, and storing materials are other important aspects of purchasing management and also form part of the logistics function which is discussed below. If materials or goods arrive late, production operations may be halted or sales lost. The problem of late deliveries must be properly addressed in order to avoid friction between supplier and purchaser. Does the problem lie with the supplier or, as can often happen, with the purchasers themselves? Poor scheduling by the purchaser can allow insufficient time for either punctual

delivery or proper quality inspections. Information concerning the receipt of wrong materials as well as items that have been damaged in transit, should also be relayed without delay to the production control and accounting departments.

Inventory Control

Businesses can only predict what customers will buy and when they will buy it. To overcome such uncertainty, stocks are kept to ensure that anticipated demand can be met. Stockholding can therefore be viewed as a buffer between supply and demand. For example, raw materials such as coal and fuel must be scheduled and stockpiled for the production of electricity, while banks have to maintain a certain level of cash inventory to meet customer needs. The main types of inventory are (i) raw materials (ii) work-in-progress (also called work-in-process or WIP) which represents partly finished products (iii) finished goods, i.e., completed products ready for shipment.

Controlling inventory is an important aspect of good management. In the past, inventories were often overstocked 'just in case' something went wrong, i.e., items were over-ordered to protect against supplier shortages or as a hedge against fluctuating price changes. However, excessive inventories tie up valuable capital as well as taking up expensive warehouse space. On the other hand, valuable sales may be lost if customer orders cannot be met because of insufficient stock. Likewise, production operations can be brought to a halt because an item is not available. Using computer models can help reduce inventory levels by providing more accurate forecasts on the quantity and timing of inventory transactions.

Common objectives of inventory control are (i) to ensure that there is a sufficient supply of finished goods to meet anticipated customer demand (ii) to ensure that there is a sufficient supply of materials to enable production operations to operate smoothly and (iii) to reduce inventory costs by taking advantage of quantity discounts or buying when prices are lower. Thus, inventory management strives to have exactly enough inventory on hand to satisfy all demands without having any excess.

There are two main classes of inventories, namely those with dependent-demand items and those with independent-demand items. Independent-demand items are those whose demands are unrelated to anything else which the company produces or sells. Independent-demand inventory usually consists of finished goods whose demand is based on uncertain environmental factors such as sales forecasts, consumer trends, etc. Independent demands are therefore full of uncertainties as to how much is needed and when it is required.

On the other hand, dependent-demand items are those that can be directly linked to a specific end-product such as the bicycle shown in Figure 1.5. In this situation, the product structure tree shows how many handlebars, spokes, tyres, etc., are required to make one bicycle. Here the demand for a bicycle automatically triggers demand for known quantities of parts and materials, i.e., there is no uncertainty associated with their demand. For example, if a customer orders six bicycles, then six handlebars, twelve tyres, 600 spokes, etc., must be in stock if the order is to be met.

Quality Control

In a manufacturing environment, the quality control (QC) function ensures that all products meet the standards specified by the engineering design department. The two main approaches

to quality control are acceptance sampling and statistical process control. The term 'acceptance sampling' refers to statistical techniques that are used to accept or reject a batch of items on the basis of a sample test or inspection. This traditional approach to quality control involves randomly selecting a sample from a batch of items and applying various tests to each item in the sample to see if it works as intended. The QC manager then extends the sample's test results to the whole batch. For example, if 2% of a sample's items are found to be defective, the manager concludes that 2% of the whole batch are also faulty.

Acceptance sampling involves the risk of finding too many or too few defective items in a random sample. If the QC manager is unfortunate in picking out too many defectives, a wrong decision will be made when rejecting the whole batch unnecessarily. The same outcome applies to accepting a batch because a sample was lucky enough to include very few faulty items.

Recent developments in computer-based systems using mechanical, optical and electronic sensors can help in non-destructive quality control, i.e., in the measuring and testing of items. Technology in testing equipment has advanced to the point where many manufacturing companies can now check out all items, thus achieving 100% quality control. The same technology cannot of course be applied to destructive quality control whereby the testing of a product involves tearing it apart to see how well it is made, e.g., strength tests of materials. In this situation, acceptance sampling is used.

The well-known advocate of quality management, W. Edwards Deming, stated that management is responsible for 85% of quality problems in a factory environment with workers being responsible for only 15%. He pointed out that workers cannot extend quality beyond the limits of what any process is capable of producing. The quality-control function is now referred to as total quality management (TQM), emphasising the strategic importance of quality to the whole organisation – not just the factory floor. TQM involves an unending process of continuous improvement with the objective of achieving perfection. The fact that perfection is never reached is irrelevant – the setting and achieving of ever-higher goals is sufficient justification.

Statistical process control (SPC) is the application of statistical techniques to the control of processes. SPC is used to ensure that a process is meeting specified standards by measuring its performance. If the process is to produce quality products, its capabilities must be periodically measured to check that it is performing as planned. The quality of the process can be affected by natural variations that occur in almost every production process. As long as these variations remain within specified limits, the process is 'in control' and quality will not be affected. However, if the variations go outside the specified limits, the process is 'out of control' and the causes must be determined. Control charts are used to separate random causes of variation from non-random causes such as operator error, faulty setup, poor materials, and so forth.

Storage and Distribution (Logistics)

The logistics function is a key aspect of production operations. Logistics is concerned mainly with the handling, storage, and movement of products to markets and materials to manufacturing facilities. For example, the logistics of a retail company involves purchasing goods from suppliers, receiving and storing such goods, and then distributing them to customers. In a manufacturing company, the logistics function is more complex because raw materials and spare parts have to be purchased and stored before the production process can commence.

When finished goods start rolling off the production line, they also have to be warehoused and eventually distributed to customers. The storage term of 'storeskeeping' usually refers to the activities associated with the storing of materials and spare parts while 'warehousing' is used for the storage of finished goods. In managing logistics, several important issues arise.

- What should be the structure of the distribution system – centralised or decentralised?
- How can warehouse and storage layouts be optimised in order to maximise space while minimising material handling costs?
- Which geographic locations provide the best benefits to the organisation?
- How much inventory should be held at each location?
- Which modes of transportation should be used?

A strategic part of logistics planning is operations layout. A layout is the physical configuration of processes, equipment, and materials that facilitates the flow of materials and personnel within and between work areas. For example, it makes sense to group similar machines together so that jobs are routed to one particular work area rather than being scattered all over the place. Poor layouts cause bottleneck queues by interrupting the physical flow of materials, and consequently add extra costs to production activities. Layout decisions should therefore be made with efficiency of operations in mind. The various types of layout include process-orientated layout, product-orientated layout, warehouse layout, and office layout.

Project Management

Project management is an integral part of operations management. Projects may involve recurring activities, e.g., plant maintenance, or they may be large one-off projects such as the construction of a new manufacturing facility. Large-scale projects consist of numerous tasks that must be completed, some in parallel and others in sequence, by various individuals or groups. Because considerable expenditure is involved, projects must be managed carefully to ensure that the entire project is completed on time. Project management comprises the important activities of (i) planning (ii) scheduling and (iii) controlling project tasks. The initial phase of project planning involves setting objectives and performance criteria (usually measured in terms of costs and time), identifying resource requirements, and assigning areas of responsibility.

The practical phase of project control is basically a comparison between what has actually been completed against what was planned at the start. Project control uses *milestones* periodically to review a project's progress. Rather than allow a project to be completed without any control checks, management designates certain intermediate points, called milestones, at which progress will be evaluated. If a milestone check indicates that a project is running late, then corrective measures must be taken to bring the project back on course.

Project scheduling focuses on the activities that make up the project. A schedule shows when each task starts and ends and how long it will take to complete the task, i.e., the task's duration. Scheduling also shows how each task is related to others in the project. Because projects often have important deadlines to meet, scheduling is a critical aspect of project management. Where

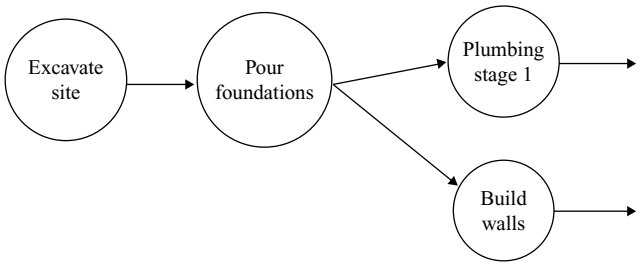

Figure 1.6 Partial network of nodes and arcs.

there is a large number of interrelated tasks, timing and co-ordination become very complex. Nowadays project managers use computer software to help them identify those tasks that must be finished on time in order to avoid delaying the entire project.

There are various mathematical techniques for scheduling projects. The two main approaches are the critical path method (CPM) and the project evaluation and review technique (PERT). These two techniques are very similar, the main difference being their assumptions concerning the accuracy of duration estimates for each task. PERT emphasises the uncertainty in estimating activity times while CPM assumes that task times can be accurately predicted. The type of questions that can be answered by using PERT/CPM are:

- When will the project finish?
- What are the critical activities, i.e., tasks which, if delayed, will delay the whole project?
- How is the overall project affected if a critical activity is delayed?
- What is the interrelationship between activities?

The CPM method is the scheduling approach used in virtually all project management software today, including Microsoft Project. All CPM and PERT models use a network to portray graphically the project's interrelationships. A network consists of nodes and arcs, also called arrows. Figure 1.6 shows the main features of a partial network. A node represents a project task (i.e., activity) and is depicted as a circle in the network. Arcs are shown as arrows and define the interrelationships between nodes, indicating what activity must end before another activity can start.

MANAGEMENT DECISION-MAKING

Management is responsible for setting an organisation's objectives. In order to achieve these objectives, management must make decisions. Decision-making is an integral part of management and occurs in every function and at different levels within the organisational structure. While the type of decisions that are made vary considerably, they can be linked to the following common managerial activities:

Planning involves (i) establishing organisational goals and objectives and (ii) developing policies and procedures for achieving those goals.

Organising is the process of (i) determining and co-ordinating activities and (ii) establishing organisational structures and procedures to ensure that the activities are carried out as planned.

Staffing entails the recruitment and training of personnel in order to achieve organisational goals and objectives.

Controlling involves (i) measuring performance against goals and objectives and (ii) developing procedures for adjusting goals or activities in order to bring them into line.

All of the above managerial functions need information to make decisions. Information provides vital input to the decision-making process by increasing knowledge and reducing uncertainty. While they are obviously interdependent, each managerial activity requires different information. For example, a planning decision utilises information concerning future events, e.g., sales forecasts, while control decisions need details of what is happening now or in the immediate past, e.g., information about machines that have suddenly broken down.

In the previous sections, the organisation was viewed from the functional perspective of marketing, production, finance/accounting, and human resources activities. Another popular way of looking at an organisation's structure is provided by the hierarchical framework of management. This hierarchical structure focuses on the decision-making process at three distinct levels namely top, middle, and lower management as shown in Figure 1.7 below. Because of the different types of decision taken at each level, top management is often referred to as strategic-level management. Similarly, middle and lower levels are also called tactical-level and operational-level management respectively.

Top Management

Top management includes the board of directors and the heads of the functional divisions of marketing, production, finance/accounting, and human resources activities. They exercise control over the long-term strategic direction of policies that determine the company's future direction. The information required for strategic decision-making is obtained largely from sources outside the company and includes such details as market trends, the competition, new product developments, etc. This external information contains a high level of uncertainty and in most cases is qualitative in nature. Information about the company's own operations is used primarily for forecasting.

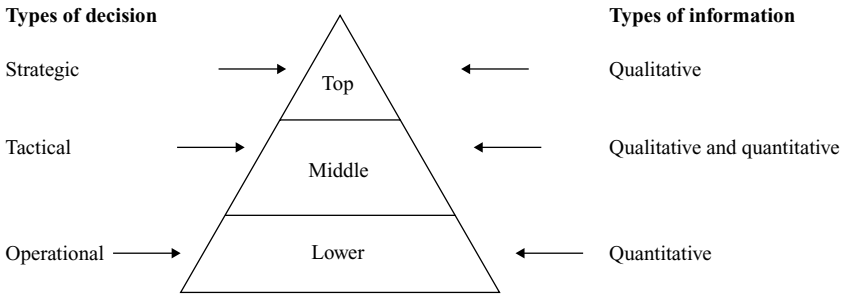

Figure 1.7 Hierarchical levels of management.

Table 1.1 Characteristics of decision-making information

	← Management Decision Level →		
Characteristics	**Operational**	**Tactical**	**Strategic**
Decision-makers	Supervisors, foremen	Departmental managers	Board of directors, divisional heads
Time horizon	Daily	Weekly/monthly	One year and beyond
Type of decision	Structured	Semi-structured	Unstructured
Decision level	Low	Moderate	Very high
Information source	Mainly internal	Internal/external	Mainly external
Information type	Quantitative	Quantitive and qualitative	Qualitative
Information complexity	Simple	Moderate	Complex
Breadth of control	Narrow	Intermediate	Broad

Top-level decisions depend to a large extent on the quality of managerial judgement based on past experience, intuition, and an element of luck. The term 'unstructured decision-making' is often used to describe strategic-level situations. Unstructured decisions involve complex processes for which no standard procedures exist to help the decision-maker, e.g., launching new products. Because strategic decisions occur infrequently, top management receives company information on an irregular basis, usually in the form of summary reports. The chief characteristics of decision-making information are shown in Table 1.1.

Middle Management

Middle or tactical management is responsible for implementing the decisions taken at the top level. It must ensure that organisational goals are achieved by obtaining and using resources in an efficient and effective way. Because middle management has the role of controlling and monitoring the organisation's various resources, it is sometimes referred to as 'management control'. Typical tactical-level decisions include planning working capital, scheduling production, formulating budgets, and making short-term forecasts. Middle management uses internal information to compare actual performance with planned goals. By analysing this information, managers are able to determine whether operations are proceeding as planned or if corrective action is needed.

Tactical-level decisions utilise both internal and external information. If a competitive advantage is to be gained, then middle management must obtain outside information on industry averages and other companies' productivity levels. By comparing these figures with their own internal productivity data, middle management is better placed to evaluate the organisation's position in the market-place. Because tactical-level decisions are based on a mixture of internal quantitative details and external qualitative information, they are sometimes called 'semi-structured'. A semi-structured problem is one where decision-makers have factual data to analyse but must also use their own judgement to arrive at a satisfactory solution.

Sensitivity or 'what if' analysis is a typical semi-structured approach in which the decision-maker asks a series of 'what if' questions in order to determine how key factors respond to

assumed changes or conditions. The ability to experiment with quantitative data in order to gain greater insight into a semi-structured situation lets the decision-maker see the consequences of certain actions. For example, a manager may wish to see how an organisation might be affected if there was a 3% increase in labour costs. Some of the models in this book illustrate the benefits of using 'what if' analysis.

Operational Management

Operational-level decisions are 'structured', i.e., they are based on factual data. Structured problems are routine and repetitive, e.g., a payroll system. They utilise quantitative information which is regularly obtained from operational activities and their outcome is totally predictable. Although a structured decision may involve complex calculations, standard techniques already exist for finding a solution. Lower management therefore makes fairly straightforward decisions that follow specific rules and patterns requiring very little qualitative input. Activities at this level include the maintenance of inventory records, the preparation of sales invoices and shipping orders, and decisions on materials requirements.

Lower management measures the efficiency of factory-level operations and takes remedial action to improve their efficiency wherever possible. Like tactical management, lower-level management is also involved with control and is often referred to as 'operational control' management. An example of operational control is the cost control of an organisation's product. Cost accounting provides a standard (or expected) cost which may be obtained from the engineering design department or may be based on past records. Actual costs of manufacturing the product are produced at the end of the accounting period. By comparing expected costs with actual costs, lower management are able to calculate cost variances and hence determine if any corrective action is necessary.

In summary, much of an organisation's information is utilised by lower-level managers with only a small percentage being accessed by top management. Exception reports, i.e., reports that focus on out-of-control situations such as inventory shortages or machine breakdowns, are important information sources for lower and middle management. Top management may utilise *ad hoc* reports to deal with unexpected one-off situations that may arise. They also use organisational information, supplemented by external market research input, to assess sales forecasts.

ENTERPRISE RESOURCE PLANNING (ERP)

In today's competitive business environment, many organisations are turning to enterprise resource planning (ERP) systems to help them manage the increasingly complex processes created by the globalisation of markets. An ERP system extends the centralised database concept to include customers and suppliers as part of the business value chain. For example, a European manufacturer may use an ERP system to process an order from a Canadian customer requiring the purchase of extra components from its Chinese supplier. The ERP system will (i) handle all currency transactions (including exchange rate conversions), (ii) update inventory and MRP subsystems, (iii) provide distributors with the necessary supplier and customer details, and finally (iv) update all accounting processes.

The model of Figure 1.3 shows how information is shared among the various subsystems of a manufacturing business. In many cases, much of this organisational information is fragmented, with key departments having their own computer systems. These stand-alone systems can create inefficiencies in the management and control of information by encouraging data duplication and the proliferation of incompatible software applications. To overcome such a piecemeal approach, database systems have been developed whereby a company's information is integrated and stored in a single source, called the database (see Chapter 7). The database concept allows users to have immediate access to the entire business information resource.

The software company, SAP – an acronym for Systems, Applications, and Products – is a major supplier of ERP systems. Numerous large corporations including Coca-Cola, Microsoft, Kodak, IBM, Intel, and Exxon have implemented SAP's R/3 software package. The R/3 product includes a fully integrated suite of programs for finance and accounting, production and materials management, quality management and plant maintenance, sales and distribution, human resources management, and project management. It is also capable of handling different countries' languages and business regulations.

The successful implementation of an ERP system can be expensive, complex, and time-consuming. For example, an organisation that wants to implement the R/3 system must first produce a blueprint of its business, involving detailed models of how each process operates. While much of the R/3 system consists of standardised modules, it is sufficiently flexible to allow customisation to meet specific requirements.

REFERENCES AND FURTHER READING

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