Chapter 13

Decision Support Systems

Learning Objectives

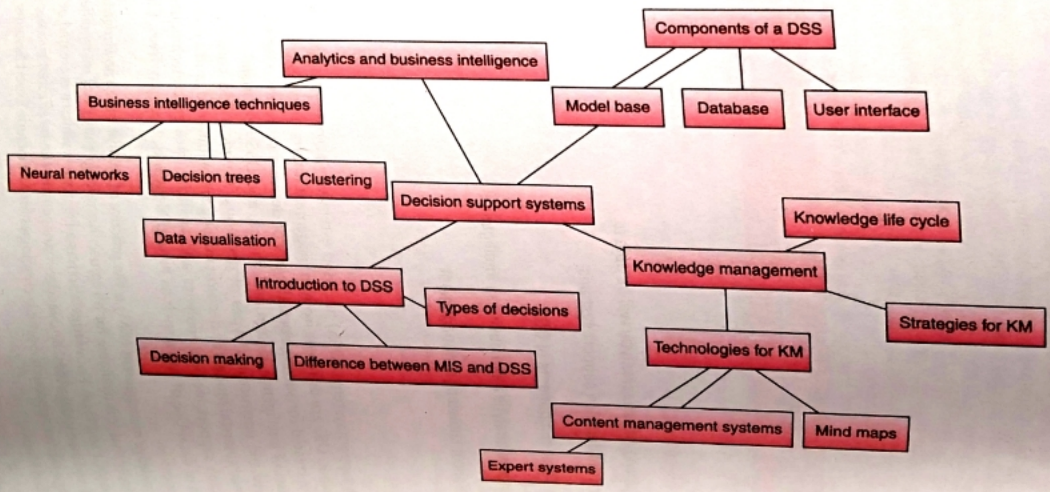
After completing this chapter, you will be able to:

- Understand decision support systems
- Learn about components of DSS
- Understand analytics and business intelligence
- Learn about knowledge management

Decision support systems (DSS) are used extensively across organisations to assist managers with making decisions. DSS are different from management information systems as they are used on an as-needed basis and created for solving special types of decision problems. Decision making by managers involves the phases of intelligence, design and choice, and DSS help mainly with the choice part. DSS support structured and unstructured types of decisions. A typical DSS consists of a database, a model base, where mathematical models of decision making are maintained, and a user interface. Modern approaches to decision support include analytics and artificial intelligence techniques for predictive and real-time analysis of data. Use of tools such as Neural Networks, Decision Trees, Clustering and Visualisation are quite extensive.

Knowledge management (KM) is the practice of codifying the knowledge of individuals and organisations in a manner that it is available for all to use. Knowledge may be of many different kinds – declarative, procedural, explicit and tacit. Knowledge also has a life cycle in which it is created or captured, developed, used and reused, and then it degrades. Knowledge management can be effected by a top-down hierarchical approach or by using a market approach. Some technologies for KM include Expert Systems, Content Management Systems and Mind Maps.

MIND MAP OF CHAPTER TOPICS



The Taj Hotels Resorts and Palaces group is one of the largest hotel chains in India, and also in the world. It has 93 hotels in 55 locations in India (in 2011), with 16 more internationally in places such as the UK, the USA, Africa, Australia, Maldives and Malaysia. The Taj hotels are known for their excellent service and high quality of properties. One of the most luxurious and expensive hotels in the world is a Taj group hotel, which was a former palace.

The Taj group is distinguished in India, as the Taj Palace Hotel in Mumbai was one of the first luxury hotels in India, having started in 1903. It stands as an icon of Mumbai, next to the Gateway of India. The Taj Palace Hotel was also the first to be electrified in Mumbai. The group was also one of the first to convert an erstwhile palace into a hotel, the Rambagh Palace in Jaipur, and a fort, the Aguada Fort in Goa, into a hotel. The Aguada resort is unique as it is built within the walls of a former Portuguese fort.

The Taj group has seen a massive growth in their business throughout the 2000s, spurred by a massive growth in the tourism industry along with the overall growth in the Indian industrial sector. The period has seen a steep increase in the demand for hotel rooms by both tourist and business travellers. The Government of India has provided the trigger for this demand by reducing taxes on air travel and thus allowing the low-cost airlines sector to bloom, increasing the number of airports and also increasing the capacity of existing airports in cities such as Delhi, Mumbai, Bangalore and Hyderabad. The Government has also initiated tourism related publicity campaigns abroad that have increased the awareness of and attraction for Indian destinations. Campaigns such as 'Incredible India' and 'Atithi Devo Bhavah' have driven India's rankings up as a tourist destination. In 2008, the global tourism magazines *Conde Nast Traveler* and *Lonely Planet* had rated India among the top five destinations in the world.

The demand–supply gap in hotel rooms is immense in India. According to industry experts, in 2008, the demand exceeded the supply by 100%. The total number of rooms available at that time was about 110,000 in over 1000 registered hotels. The industry demand has driven the prices to rise at the rate of about 25% annually, with occupancy rates rising at 80%.

To manage its large fleet of hotels, the Taj group uses IT extensively. It has implemented an ERP package to manage supplies and finances. The system has helped hotels manage a very large stock of inventory items such as shampoos, cooking oils, etc. The hotels also use a system to manage room reservation centrally. This system is supported by a call centre that can handle over 2000 calls daily. Furthermore, the group uses a CRM system that keeps track of all users, what rooms they usually book, in which hotel and what their preferences are. With such a system, managers can plan for prices of rooms and bookings.

A problem that hotels face is that of limited supply. A hotel only has a fixed number of rooms that it can offer in a day, and so the value it can realise by providing fixed prices is also limited. Following a strategy, that most hotels do, of maximising their room utilisation leads to a situation where the maximum value is also fixed.

However, many experts offer a way to overcome this maximum by a technique of revenue optimisation (RO). Here, the hotel managers can use a forecasting system to determine what their demand is and then take chances of offering higher prices to lesser customers to obtain higher value realisation. The Taj group experimented by implementing such a package.

The Taj managers found that they have a pattern of room utilisation across cities, with Delhi and Mumbai at a higher utilisation than Bangalore. But, they also noted that the revenues realised at Bangalore were higher. This was a result of a peak demand period in Bangalore (around the Dussehra period, usually in October, when many tourists arrive to see the festivities in neighbouring Mysore city), when higher prices could be charged.

RO works on the principle of offering rooms at higher prices to lesser number of visitors, rather than lowering prices to fill up occupancy. If a group of four demands four rooms at Rs 10,000 (USD 220) each then the management has the option of refusing them the bookings, hoping to offer the rooms at Rs 15,000 (USD 330) each. This would bring a higher realisation, an additional profit of Rs 5000 (USD 110), even by booking only three rooms. However, here is a catch – the management should be reasonably sure that three new customers will ask for rooms, even at the higher price of Rs 15,000. Or else, the hotel will lose the revenue that was sure to come from the lower price of Rs 10,000!

The RO software is a decision support software that forecasts demand based on past record of reservations. It allows the managers to price each room based on the highest value that can be realised. The software uses a mathematical model to show the managers the risks associated with denying reservations at a lower price and waiting for buyers who will pay the higher price. Thus, the managers can make the decision with confidence, based on the rigorous analysis carried out by the RO system.

The value of decision support with the RO system, experts note, is that it takes the focus away from cost minimisation that IT is usually used for, and focuses the attention on profit maximisation. The Taj group was able to use the RO system very effectively. After introducing the system, the group increased its revenues dramatically, with average room rates increasing by as much as 35%.

The techniques of RO work effectively in situations where demand exceeds supply and this can be accurately predicted. A hotel can afford to turn away customers, and go against the conventional wisdom only if they have the confidence that they can charge higher revenue from the other customers who will arrive later. This confidence is provided by the system that relies on historical data of demand and the patterns that it can determine about seasonal usage, variations in demand and changing preferences.

13.1 DECISION SUPPORT SYSTEMS

Decision support systems (DSS) are a kind of application software used by organisations to help make decisions regarding day-to-day operations or about long-term plans and strategies. These systems typically use data available within the organisation to analyse and present alternative scenarios to managers. The systems may use data from outside the organisation too, where the challenge is to ensure that the data is relevant and reliable. The following example on the use of a DSS will help clarify the manner in which the system is used.

A manager in a large manufacturing facility has to decide on the number of lots of raw material to start processing on a daily basis. The factory manufactures extruded metal pipes that are used in the energy industry. Each lot consists of short and thick pipes that are passed through several stages of cold extrusion, then cooling and processing to retain the structural properties of the metal. At each stage, the extrusion machines are limited and highly specialised for the dimensions of the input and output extrusion pipes. The manager has to decide carefully how many lots to select at the input stage, as too many lots will cause unwanted queues and bottlenecks. In contrast, too few lots will underutilise the expensive extrusion machines.

The manager uses a DSS to make his decisions (see Fig. 13.1). The DSS takes as input the current status of the shop floor: How many lots are currently being processed, what is the status of queues at various machines on the shop floor, the time available for the processing (or when the final products are due for the current lot to be processed), whether there are any machines undergoing maintenance and how long that will take and so on. With this information the DSS is able to compute alternative scenarios for the manager regarding the type of and number of lots to release into the system and the time they will take to get processed. The alternative scenarios are computed on the basis of a mathematical 'model' already built into the system. With the system, the manager can try 'what-if' scenarios for his decisions – what if one additional lot is included, or what if two additional lots are included, and how will this affect the final outcome, how will the queue sizes change and so on.

It is important to note from the above example that the system only helps the manager make the decision – it does not make the final decision by itself. The system

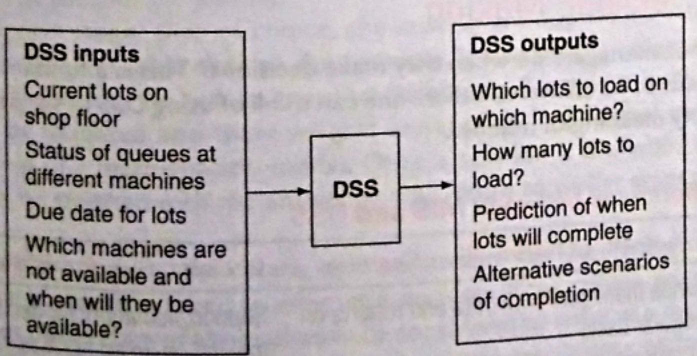


FIGURE 13.1 Example of DSS inputs and outputs for decision making at the shop floor of a manufacturing facility.

does not replace the manager; it simply assists the manager to arrive at a decision. Furthermore, the decision is structured in nature because the number of variables that have to be decided on are known clearly, which are the kind and number of lots to release. Also, there is a pre-existing model of the problem, one that is used to arrive at the possible scenarios of interest to the manager.

DSS are widely used in organisations. They may be used to select stocks to invest in the stock market, to determine which routes to follow to supply goods to various retail outlets, to determine which employees to enlist for a given project or to determine how to allocate budgets to different products based on their sales. Such decisions are helped by predetermined models that allow the decision maker to input the relevant data and then compute various alternative scenarios. DSS are used individually by managers and executives, and also by groups that are working on a particular problem domain.

13.1.1 MIS and DSS

Management information systems or MIS have been covered in an earlier chapter (Chapter 2). MIS essentially present data to managers in various forms and from various sources. The intent of MIS is to enable managers to see the data pertaining to the functioning of the organisation in a summary manner that enables both a bird's eye view as well as a penetrating view of the data. MIS too process the data but in a manner as to show different views and summaries. DSS, on the other hand, are designed to help managers with decisions, and the analysis is meant only for a particular decision.

DSS are used infrequently, mostly on an ad hoc basis, when a decision has to be made, whereas MIS are used regularly. DSS analysis allows the manager to assess various scenarios and alternatives, whereas MIS reports have a fixed output and format. Furthermore, DSS are designed for users and managers across the hierarchy of the organisation. Those who work in situations, which can be assisted by DSS tools, rely on them. In contrast, MIS reports are largely used by higher management in the organisation, who need to see summary and regular reports. Broad differences between MIS and DSS are listed in Table 13.1.

13.1.2 Decision Making

What is it that managers do when they make decisions? This is a fundamental question that needs to be answered before one can think of using DSS to support decision making in any meaningful manner.

Table 13.1 Differences between MIS and DSS

Management Information Systems	Decision Support Systems
Provide managers with data and reports on a regular basis	Support managers for decision making on an ad hoc basis
Reports are targeted for specific users, especially management	Find use across the organisation, by whoever needs help with problems.

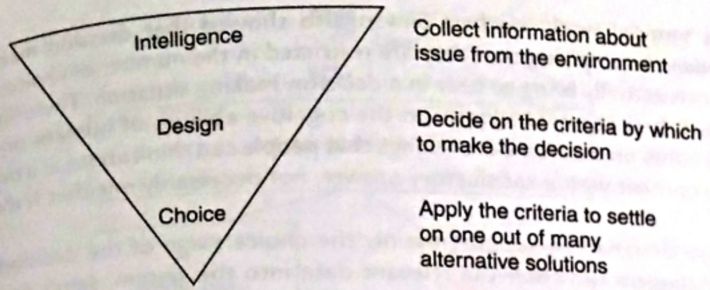


FIGURE 13.2 Phases of problem solving in the Intelligence–Design–Choice Model.

Herbert Simon, the Nobel Prize winning researcher, showed that humans went through three essential stages in the act of problem solving. He called these the *Intelligence*, *Design* and *Choice* stages. Decision making can also be considered as a type of problem solving. When making a decision, humans tend to follow Simon's Intelligence-Design-Choice Model, shown in Fig. 13.2. In the first stage, that of intelligence, they collect information about the issue from the environment and the surrounding context. For example, if a person is faced with the problem of travelling from Bangalore to New Delhi, a distance of about 2000 km, then in the intelligence stage the person will seek all possible information of how to travel – by air, by train, by bus or by a personal vehicle. This inquiry is open-ended and will involve searching for all possible avenues by which the problem can be solved.

Once the intelligence information is available, the decision maker moves on to the next stage which is the design stage. The question addressed at this stage is – What criteria should be used to decide between the alternative possible solutions to the problem? This question requires the decision maker to settle on the criteria that are important, and then select or rank-order them. For example, the choice of cost and time may be the most important criteria for the decision-making process. In our example of the Bangalore–New Delhi journey, it may also be specified that no more than a certain amount of money may be spent and no more than a certain amount of time can be used for the journey.

At the next stage, that of choice, the criteria are applied to select the best answer from the available choices. For example, based on the criteria of cost and time available, it may be best to travel to Delhi from Bangalore by train. The criteria may be weighted and these weights are applied in a formal manner, often with the help of a mathematical model. Once a solution is available, the decision maker may be satisfied with the answer or may return to earlier stages to redo the process.

At the choice stage, the criteria and parameters for the decision help curtail the amount of search required to arrive at a decision. If the criteria are not specified sharply then the number of alternatives to be considered to arrive at a decision may be very large. This stage may also require returning to the intelligence gathering activity, and then to the design stage to change or modify the criteria and the weights used to apply them.

In his seminal work, Herbert Simon also showed that decision makers have *bounded rationality*, implying that they are restricted in the number of choices and criteria they can actually bring to bear in a decision-making situation. These limitations exist, in part, because of the limits on the cognitive abilities of humans or, in other words, the limits on the number of things that people can think about at a time. Most people are content with a satisfactory answer, not necessarily one that is the best or optimal.

DSS are designed to support mainly the choice stage of the decision-making process. Managers can enter the relevant data into the system, select or prioritise their criteria and let the system decide on the final solution. Mathematical models are usually built into the system to help analyse the data and arrive at solutions. Some modern software also assist decision makers in the intelligence stage, where they seek out pertinent information from organisational databases or from the Internet.

13.1.3 Types of Decisions

DSS are typically used to support what are called ***structured*** decisions. In a structured decision-making scenario the relevant criteria, the data needed and the method of analysis are usually known and can be modelled by the system. For example, the *travelling salesman problem* is a very well-known structured problem (see Fig. 2.8 in Chapter 2). In this problem, the data on the number of cities the salesman has to visit, the distance between the cities and the criterion for selecting the tour for the salesman (which is the lowest cost route that he can take calculated on the basis of distance), are all known. The problem is to then find the best solution among the many possible tours the salesman could go on. DSS effectively tackle such structured problems. However, it should be mentioned that the travelling salesman problem is very hard to solve, especially if the number of cities exceeds 30.

Unstructured problems do not have clearly defined parameters or criteria for selecting solutions. For example, finding the best candidate for filling the position of a chief executive officer of a firm is an unstructured problem. The criteria may not be sharply defined, the parameters by which to describe and evaluate the candidates may also not be sharply identified, as they pertain to subjective concepts like personality, leadership skills, vision, motivation and so on. Unstructured decision problems are usually solved by imposing some form of structure in order to apply the analysis and select the best candidate. For example, to choose between several candidates for the chief executive officer position, the decision makers may create a scale on which to rank the candidates on the subjective parameters. These ranks can then be used objectively to select the best candidate.

A large class of problems are of the nature of semi-structured problems – where some parameters are specified, but other parameters have to be determined by studying the problem domain carefully. The problem of finding the best marketing campaign for a product, for example, is a semi-structured problem where some parameters such as the budgets, the target population, etc., are known, but others such as the effectiveness of the media may not be known. DSS are used in cases of semi-structured problems with some assumptions and some imposition of structure.

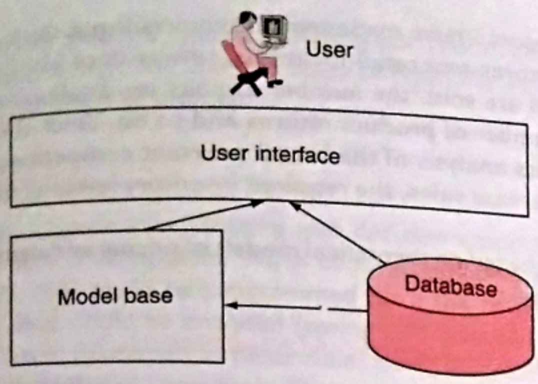


FIGURE 13.3 Components of a DSS: The database, the model base and the user interface.

13.2 COMPONENTS OF A DSS

A DSS consists of three main components, the database, the model base and the user interface (see Fig. 13.3) that are described below.

13.2.1 The Database

A DSS relies on a database component that stores, manages, retrieves and presents data in a suitable manner. The DSS database relies on organisational databases, and as such has functionality similar to that of databases covered earlier. The difference is that the querying and reporting of data are done by and for the DSS itself.

13.2.2 The Model Base

The model base consists of the mathematical or other models that are used to compute the answers for the problems posed to the system. Model bases typically consist of various types and kinds of models that are designed for different problem domains. For example, the model base may consist of an algorithm for solving the travelling salesman problem and another one for inventory management. The models are derived from known solutions to problems and may be tailored to the organisation's needs.

Each model in DSS needs particular kind of data that it draws from the database. The data has to be provided in a form that the model can use, and this often requires pre-processing of the data. Provided below are some examples of models that are used in DSS and the input data they require.

13.2.2.1 *Models of Brand Management*

Marketing managers have to make decisions about the products and brands that they are responsible for. One aspect of their job requires assessing the current position of the brand in the market with regard to its competitors, while another part requires deciding on what steps to take with regard to price, promotion, retailing, distribution, etc.

A DSS to support brand management requires input data about the sales of the brand at all stores and retail locations, similar data about competitors, the prices at which all are sold, the number of units on display, the number of days on display, the number of product returns and so on. Once the data is available, the system presents analysis of the brand's current competitive position, its possible pricing to increase sales, the required inventory levels at different stores and so on.

The analysis is based on theoretical models of pricing and demand, and on inventory and sales models.

13.2.2.2 *Models of Portfolio Management*

Finance managers of firms have to make decisions regarding investment in various financial instruments. These instruments consist of different kinds of stocks, bonds, mutual funds and derivatives. The investment decision is based on the data about the prices of these products, their expected returns, the risk profile they have, and their market volatility among other parameters.

Models for making the portfolio decision are based on theoretical models that determine how much to invest over a given time horizon in the different investment vehicles. The models show alternative investment scenarios and enable the users to vary their risk profile or preferences to see their impact on the portfolio allocations.

13.2.2.3 *Models of Human Resource Management*

Many organisations have to solve the problem of employee allocation. They have to decide which employees to allocate to different projects they have. The inputs required for this decision are about the employees, their experience, skills, job preferences and their current allocation to different tasks. The models in the system use theoretical models of resource allocation, with constraints, to identify which employees should be allocated to what tasks. For the models to arrive at accurate decisions the details about the requirements of various tasks also have to be specified.

13.2.3 The User Interface

The third component of the DSS is the user interface. This is a software application that allows the user to access the database easily and also put the data into the model base for analysis. The user interface may consist of the typical tools and icons available on any interface, such as drop-down lists, buttons, menus, text-entry boxes, dialog boxes and so on.

User interfaces also guide the user to select models appropriate for the problem by providing tips and suggestions. The design of user interfaces is based on how humans solve problems and the guidance is according to how the user progresses with using the data for building models. User interfaces now also have a component that is able to interpret natural language. The user types his/her problem in English, *for example*, and the then the system interprets the user's commands to come up with an appropriate model. The user can select or reject the model and then further refine the requirements of the problem

13.2.4 History of DSS

The idea of using computers for assisting with decision support co-evolved with the use and development of computers. When computers were limited in their capacities, in the 1960s, they could be programmed for a few activities and also only a small amount of data could be analysed (owing to limitations of memory size and speed). The DSS tools developed at those times were designed to help with specific tasks that could be modelled adequately. These systems were known as model-driven DSS (this name was given later), and were based on numerical or statistical or computational models of business, for applications in accounting, finance and production. The model parameters were specified in advance, and given data about a new situation, could compute various values for use by managers. Managers could also change the data values to see the effect on the eventual result. This was known as 'what-if' analysis.

When the first spreadsheets were developed in the 1980s and became popular applications on personal computers, they allowed users to build numerical and statistical models, which could be used with data sets for decision support. What-if analysis gained popularity as data could be easily changed in spreadsheets to see what effect they had on various parameters. For example, budget planning is often done on spreadsheets. The numbers in a spreadsheet for the budget can be easily changed to see the effect they have on the overall budget.

A tool that gained wide popularity in spreadsheets is the pivot table. A pivot table allows data to be summarised, sorted, cross-tabulated and aggregated quickly. The tool allows the data to be visualised in different ways, enabling decision makers to see the patterns and trends in their data. For example, Table 13.2 depicts the data from the Classic Models payments table (discussed in Chapter 11). The data is arranged in rows, corresponds to the payments made by different customers on different dates. A simple pivot table (Table 13.3) shows the data aggregated according to customers, to show what payments they made on what dates. The pivot table leaves out the check numbers data, which is not relevant for this analysis.

Table 13.2 **Customer Payment Data**

customerNumber	checkNumber	paymentDate	amount
103	HQ336336	19/10/04	6066.78
103	JM555205	05/06/03	14,571.44
103	OM314933	18/12/04	1676.14
112	BO864823	17/12/04	14,191.12
112	HQ55022	06/06/03	32,641.98
112	ND748579	20/08/04	33,347.88

Table 13.3

Pivot Table Showing Individual Customer Payments

customerNumber	paymentDate	amount
103	05/06/03	14,571.44
	19/10/04	6066.78
	18/12/04	1676.14
112	06/06/03	32,641.98
	20/08/04	33,347.88
	17/12/04	14,191.12

Pivot tables are available in all popular spreadsheets. Even today they are a very powerful decision support tool.

As computational power improved in the newer versions of computers, the decision support paradigm shifted to a more data-driven approach. Large volumes of data were available to organisations from databases, and these could be analysed with various tools, including models. This field evolved into what is now referred to as data mining, analytics and business intelligence.

Group Decision Support systems (GDSS) emerged in the late 1980s with the goal of enabling a group of people to participate in a decision-making exercise jointly. The need for such types of decision-making systems arose from the fact that in most organisations, high level decisions are typically made by a group at a meeting. While they could work on individual DSS, the real value of the system would be if their group thinking was somehow captured. The design for such systems was proposed by academics who studied group decision-making behaviour in laboratories and arrived at a number of features that would assist the group.

The typical design of a GDSS involved group members sitting at computer terminals in a room, with a central, shared projection facility that shows the computing results of the group. All the computers are linked to the GDSS software that coordinates the activities of the group members, and also manages the data and models that the group uses. A facilitator starts the process and coordinates activities for the group. Group members can make contributions to the data or models or ideas being discussed, at any time, and anonymously, if needed. A session at a GDSS meeting is expected to involve phases of idea generation, consensus building, idea consolidation, evaluation, and policy writing.

1. At the idea generation phase, the GDSS provides facilities for electronic brainstorming – which is the process of free thinking on a problem and adding ideas for possible solutions. The system enables contributors to add suggestions and comments to existing ideas, while developing independent lines of thinking.
2. At the consensus building and idea consolidation phases, the participants may vote on the best ideas, or fill out an electronic questionnaire to rate the best ideas and suggestions. Ideas may be depicted graphically as maps or node-link graphs, illustrating the relations between concepts.

3. At the evaluation phase, the system may enable polling or rating to identify the best solutions to the problem.
4. At the policy writing phase, where the solution found by the group is elaborated into a policy text, the system helps with providing modelling tools, data and analysis tools to elaborate on the solution and write its implications.

GDSS also account for disagreements and conflicts in the decision-making process. Stakeholders of different ideas can be recorded, and the history of the process can be revealed to show the origin of conflicts, and point to how they can be resolved.

Many commercial GDSS tools were developed, along with physical facilities where such sessions could be conducted. The evaluation of these tools showed that they were quite successful in helping groups arrive at decisions collectively. Some drawbacks included slowing down the process of conversing and restricting the easy flow of ideas.

Currently, GDSS tools have been largely replaced with online collaboration tools such as wikis, Googledocs and rating systems, which many organisations have adopted internally.

Along with the growth of GDSS, decision support systems specifically targeted at senior executives were also designed. These are known as executive support systems (ESS). These systems have similar capabilities as DSS, with the difference that they rely on heavy use of graphical presentations. ESS typically have a dashboard display where they depict the status of different parameters of the organisation in graphical format. The emphasis in dashboards is on depicting the current state of the organisation, via the parameters, along with facilities to drill-down to uncover details.

13.3 ANALYTICS AND BUSINESS INTELLIGENCE

Modern organisations are rich with data. Owing to large-scale computerisation efforts, almost all processes, activities and interactions within the organisation are available in accessible databases. This rich data environment has spawned a variety of software applications that rely on the principles of decision support systems (DSS) and enable organisations to change their competitive strategy. These applications rely on fast computing architectures, a large collection of historical data, access to data being produced currently in the organisation, and computing software that enables complex models to be used for analysis. This approach to using data analysis is widely known as *analytics*.

Firms have changed their ability to compete in markets by using analytics in ways that are new and innovative. One problem that has received considerable attention is that of *predictive* analytics. In predictive analytics, the challenge is to use historical data effectively to predict aspects of the future that are important for the business. For example, a loan processing officer in a bank, which specialises in providing loans to small businesses, has a rich historical data bank on the loans given in the past, the characteristics of the firm the loans were given to, the repayment schedule and the performance of the borrower for returning the loan. For a new loan applicant, the officer can use the historical data and run it through the analytics software to predict how the current applicant will perform. The officer relies on the power of the models, based on statistics and other techniques, to have a very good estimate of the risks involved and can make a better decision as compared to his/her counterpart in a rival lending agency that does not use such kinds of analytics tools.

Predictive analytics has many applications in business. For example, mobile phone services firms have a problem of their customers 'churning' away, or switching services to rival firms. Such customers are dissatisfied with offerings of their current provider, or are attracted by better features or services of other firms. Some firms use analytics to determine which of their thousands of customers are likely to churn away, or switch their service to a rival firm, and then these customers are provided incentives, such as reduced prices, to stay on. The prediction of churn is based on the relative decline in usage, offers by rival firms, change in calling patterns and complaints from customers.

Large manufacturing firms have to manage a pool of suppliers who provide them with the essential raw materials to run their manufacturing activities. One management challenge these firms face is that of predicting suppliers who will default on supplies or on delivery. Predictive analytics is used to analyse past patterns of activity of all such supplier firms and understand the trends in the patterns. For example, if a supplier has had a recent history of delays in delivery, or quality problems, or batch-size problems, analytics can highlight this and enable the management to correct the problem before it assumes serious proportions.

Customer relationship software is used to monitor a commercial firm's interactions with its customers. Based on patterns such as buying activity, level of transactions, use of credit and so on, the firm can offer promotions and deals to its customers. The analytics results point out the customers to whom offers can be made profitably versus others.

Another area in which analytics is used increasingly is that of *real-time analysis*. Firms that have large-scale ongoing transactions, such as e-commerce firms, want to monitor and analyse trends. Software applications monitor the stream of transaction data in real time, that is, soon after the transaction data is created, and measure the data for trends. Such monitoring allows firms to make pricing, load balancing and resource allocation decisions quickly. Furthermore, these applications create a *dashboard* of monitors that provide a continuous stream of input data to be seen in a summary. The dashboard interface resembles the dashboard in a car, showing performance indicators with graphical displays.

For example, an e-commerce firm uses real-time analytics at a call centre to monitor the load on various operators who answer customer calls. The operators are assigned to calls based on the type of information required, and if the load increases on a set of operators, the software suggests moving the load to others. The entire operation is monitored by the software, and the data trends are compared with past trends and also with loading policies. An insurance firm uses alerts about competitor prices, which are provided to all its agents on a real-time basis, to enable them to price their products competitively.

13.3.1 Business Intelligence Techniques

Analytics relies on a number of computational and statistical techniques that were developed in the field of artificial intelligence. When applied to business problems, these are known as business intelligence techniques. Brief descriptions of some business intelligence techniques are provided below to highlight the kind of problems that can be solved and the kind of data that is required.

13.3.1.1 Neural Networks

A neural network is a mathematical model of neurons in animal brains. The network consists of nodes and links between them. One set of nodes are called input nodes, and input data is provided to these nodes. These nodes are connected to many others in a specified manner. Another set of nodes are called output nodes and here the computations of the network are terminated. When data is provided to an input node, the idea is to move the data through the network, and as this is done, certain calculations are performed. Data is 'moved' through the network by allowing it to be used in calculations from a source node to a destination node that is connected by a link. Data from a particular node cannot be used in a node to which that particular node is not linked.

Each link in a neural network has a weight. This weight is initially randomly assigned. In the most widely used form of neural network, data is propagated through the network in a single direction, from input to output nodes. The weights on the links are used to make the calculations as the data is moved.

Neural networks are used in two types of analytics problems:

1. Classification.
2. Prediction.

A classifier takes input data and puts it in one of several known categories. For example, neural networks are used to determine if a loan should be given to an applicant at a bank. The network has to be given past data of sanctioned loans given, and whether the borrower had paid them back according to the contract. The input data can include the amount of the loan, the profession of the borrower, the income of the borrower, his/her debts, age, gender and the reason for applying for the loan. The data may contain details about the borrower's repayment history, and the defaults on the repayment, if any. Most importantly, the data also contains specific categories of giving or denying a loan (see Fig. 13.4). The neural network is then 'trained' on the given data, where the details of each loan processing instance are provided along with the final decision of whether the loan was given or not. The training procedure is built into the software, and consists of elaborate mathematical procedures that adjust the weights on the links in the network. Once trained, the network will be able to tell from the given input data whether a loan was approved or denied. When the data on a new case is given to the network, it is able to classify the applicant as one to whom to give the loan or deny.

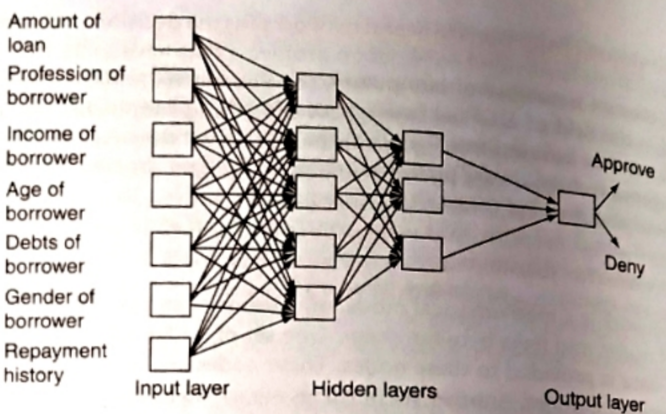


FIGURE 13.4 The neural network for loan processing problem. The input layer consists of seven nodes. The output layer consists of one node. The inner layers of nodes are called the hidden layers.

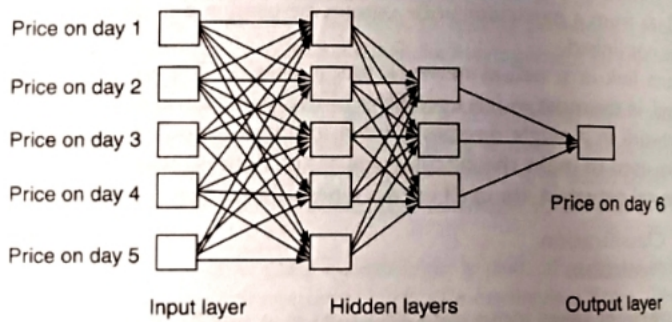


FIGURE 13.5 The neural network for stock price prediction. The network consists of five input nodes and one output node.

Classifiers are used to distinguish between categories of objects and groups. Classifiers are used to distinguish between promising customers and not-so promising ones, reliable and unreliable borrowers, products that are likely to be more successful than others, suppliers who are likely to be more reliable and so on. Classifiers require historical data on which to train the neural networks, and then can adequately classify objects based on the decision situation.

Prediction problems involve forecasting a number or a value for future, based on past data. Neural nets are used to predict the movement of stocks, the price fluctuation in exchange rates, the volume of sales for different products, the capacity utilisation for airlines and so on. Prediction requires a long stream of past data on which the neural networks can be trained. For example, for a given stream of data on prices of stocks, the training is done by giving as input, say, 5 days of data about certain stock prices, where the output is the price on the sixth day (see Fig. 13.5) Thousands of data points are used to provide values for the ten input and one output data required. Once properly trained the neural nets can predict the next day's price of a stock, based on the last 10 days closing prices of the same stock.

Construction of appropriate neural networks for the decision problem at hand is a challenge. There are a number of design problems that have to be solved, such as: How many nodes are required, how are they to be connected, what training algorithm should be used (of the many available), how should the data be broken up into sets for training the networks and so on. In most cases, these design issues are resolved by experimentation. Various networks are trained and tested, and the one that gives the lowest error on a data set, which is distinct from the set the network is trained on, is selected as the best network for decision support. The design, training and testing of neural networks for specified tasks is a time-consuming activity. However, once the networks are trained, they can be used very efficiently.

13.3.1.2 Decision Trees

A decision tree is used in a manner similar to neural networks, but only for classification problems. A decision tree is built with past data and is used to classify fresh data from the same type of problems. An example of a decision tree is shown in Fig. 13.6. The figure shows a decision tree for the problem of deciding to give a loan to an applicant. The tree begins with the most important parameter for making the decision, which is that of the 'income' of the applicant. This parameter is assumed to have three different values, those of 'high', 'medium' and 'low'. For each of these values there is a branch of the tree. If the applicant has a high income, then the tree considers the next important parameter on that branch of the tree, which is 'repayment history' of the applicant. This parameter then becomes the starting point of another branch of the tree, where two values are considered 'good' or 'poor'. If the repayment history is good then the decision to give the loan is a 'yes'. The yes node does not branch anymore and is considered a terminal or a decision node.

Going back up to the 'income' node of the tree, we find that the value of 'medium' income leads to another branch, where the next parameter is 'profession'. This parameter has two values 'self-employed' and 'salaried'. These branches end in terminal nodes with the decisions of 'no' and 'yes'.

The third branch from the 'income' node has a value of 'low' and leads to a node called 'education' which has two values 'graduate' and 'high school'. All the branches of the decision tree terminate in decision nodes.

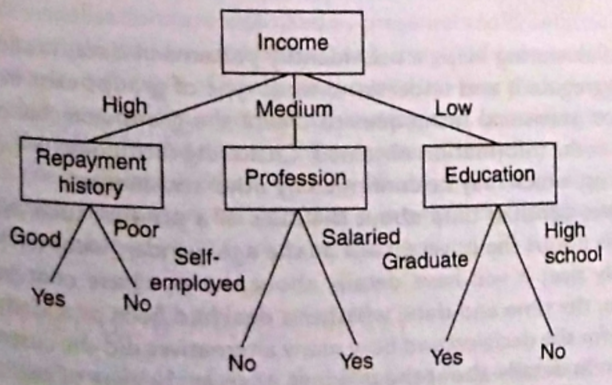


FIGURE 13.6 The decision tree for loan approval.

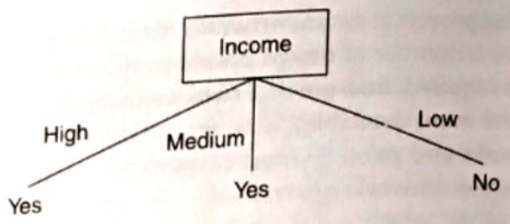


FIGURE 13.7 A simpler decision tree for a loan approval process.

A decision tree allows a decision maker to determine the most important parameters for a decision from historical data and use these to arrive at the best decision. Each tree is constructed by seeing data from past transactions and the decisions that were taken in those cases. The method for constructing the tree relies on a statistical technique. In this sense, the decision tree is similar to a neural network in functioning. However, it has one advantage in that it specifies which parameter is the most important for the decision. In the given loan example, the most important parameter is 'income'.

Decision trees can be very simple, or very complex. The simpler they are, the better it is for the decision maker. Consider a decision tree that is another solution to the same problem of classifying a loan applicant (see Fig. 13.7). The tree here has only one node and three branches. The branches end in terminal nodes with decisions. This tree is very small and robust. It will have an answer for all applicants very quickly, and this can be determined with hardly any calculations. However, decision trees can become quite complex and have thousands of nodes and branches, depending on the size of the decision problem. A simple and small tree is the most general and has the most robust answers for most types of problem situations.

The construction of decision trees is far easier than that of neural networks. The algorithms that construct decision trees also determine the number of nodes and branches required. The designer has to ensure that the number of cases to train the tree are adequate, and also test the tree for errors of classification. Another advantage which decision trees have over neural networks is that the data can consist of text values also, whereas neural networks can only handle numerical data.

13.3.1.3 Clustering

The method of clustering helps a user identify patterns in data. It allows one to see how data is aggregated, and understand what type of groups exist in the data. The methods rely on statistical techniques to create the groups or clusters, so there is high reliability in the information obtained. Clustering techniques are usually used to discover patterns, which may be confirmed by other techniques.

For example, consider data about the sales of a product such as car. The data will have details about the buyers, such as the age, gender, income level, education level and family size; it will have details about the purchase context, such as the location of sale, the time and date, whether a deal had been provided, how long the customer took for the decision and how many alternatives did the customer consider. It will also contain details about the product, such as the type of car, the number of doors, its capacity, its mileage and so on. When such data is available on thousands of car purchase transactions, groupings within the data may be discovered by using cluster analysis. For instance, the cluster analysis may reveal that most buyers of sedans, or large family cars, buy them when a deal is available and typically in the last quarter of the year, such as in the period October to December. Such information is useful for marketing managers to plan their strategies and target specific consumers through advertisements and campaigns.

13.3.1.4 Data Visualisation

There is a famous Chinese proverb that translates loosely as 'a picture is worth ten thousand words'. This proverb highlights the power of visuals and images to convey meaning, something that would take a lot of effort to express in words. In DSS design, too many modern designers have adopted advanced visualisation techniques to assist decision makers. See Fig. 13.8 for example of data visualisation.

For data analysis, there are many graphical techniques that are well known and are available to most users of software packages. These techniques include scatter plots, charts of various sorts, histograms and box and whisker plots. These techniques are used extensively to render summary data or provide a graphical description of data. The data sizes may run to thousands of data points. However, a simple histogram can show how data is aggregated, and a scatter plot can show how data is distributed. When data is static and does not have many variables, these techniques are usually adequate for helping decision makers.

However, when data becomes complex, with many variables and with wide deviations in the variables, or when data is not static, that is, there is a continuous stream of data that has to be understood, then more complex data visualisation techniques are used. Some techniques reduce the dimensions of data, that is, they reduce the number of variables in the data and then allow the user to make judgements, visually, about the entire data set. Other visualisation techniques present the dynamic data stream as a set of plots on a screen that is constantly changing, or as a scale, as on the dashboard of a car, which is showing some parameters of the data.

Many techniques are used to show extreme data points and outliers in data. The objective of these techniques is to show if there are certain data points that are not part of the main data set, or they are outliers, and need special attention. Outliers are difficult to identify through statistical techniques, and sometimes humans can spot them visually.

Dynamic data visualisations are also used by presenters to dramatise and emphasise a point. For example, to show trends in, say, usage of computers, a presenter may show the increase in the use of computers over a 10-year period not as a simple increasing graph, but as a dynamic graphic of a rising and expanding bubble, where the size of the bubble depicts the number of computers, and the vertical position of the bubble shows the population of users, both of which are increasing. This type of presentation impresses upon users the fact that not only is the number of computers increasing, but the number of users is also increasing.

13.4 KNOWLEDGE MANAGEMENT

Knowledge management (KM) refers to the practices that organisations follow to identify, capture, store and reuse the insights and experiences of their employees

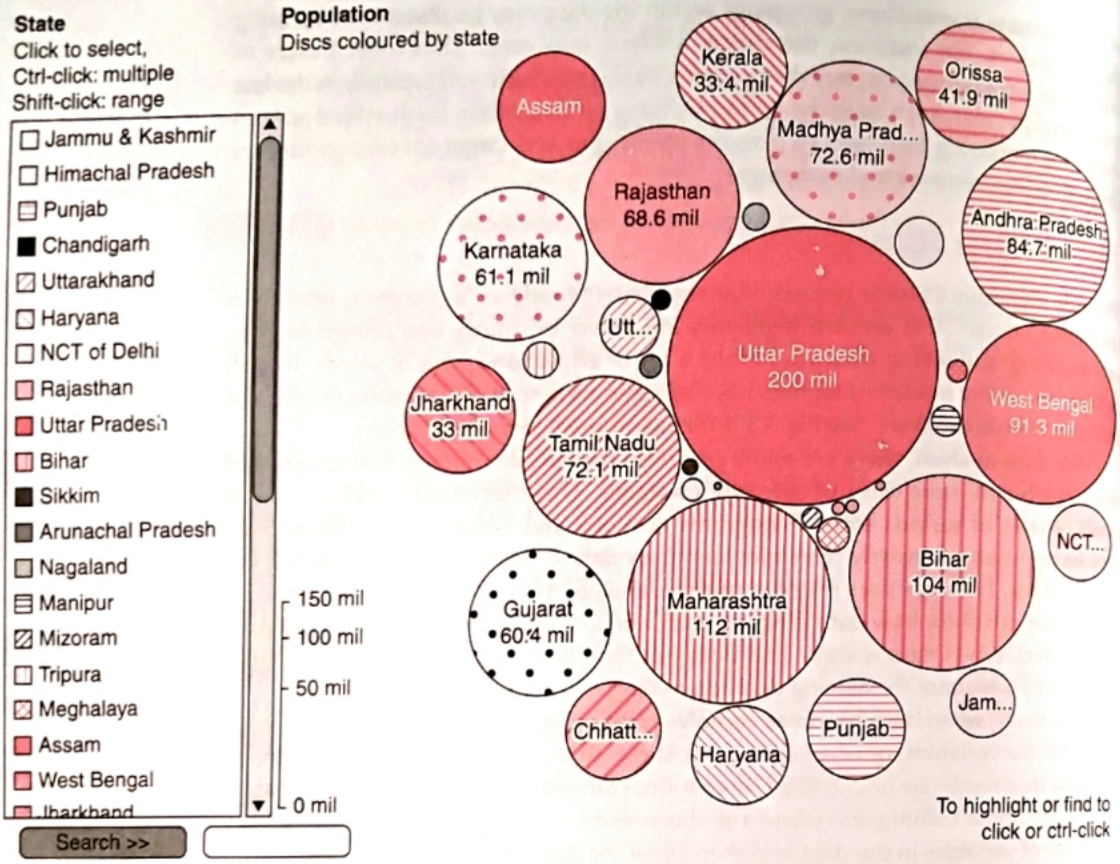


FIGURE 13.8 Bubble chart of populations of different states of India.

Source: Visualization created at Many Eyes, an online application is available at http://www-958.ibm.com (Reproduced with permission).

and the codified experiences that are stored in their data and information repositories. Knowledge is itself a difficult term to define as it has many meanings and connotations. In the organisational context, knowledge is separated from, and is at a higher level from, both information and data. If data is raw facts about things stored in databases, and information is the processed data, then knowledge is insight obtained from information about things related to the organisation and to the context.

Knowledge is understood in the knowledge management context in many different ways. Traditional approaches of representation categorised knowledge in two different ways:

1. **Declarative knowledge:** It is about invariant facts or descriptions. For example, the room number in a building in which an office is located is declarative knowledge. It has a context in which it has a meaning, and this remains fixed as long as the context remains.
2. **Procedural knowledge:** It has to do with how things are done. For example, how to find an office in a building is procedural knowledge.

These two types of knowledge differ in the way they are represented in DSS and other systems.

In the organisational context, knowledge is categorised as either *explicit* or *tacit*. (1) Explicit knowledge is that which has been codified in some manner and is available within organisational systems. It could reside in documents, manuals, procedures implemented in application systems or a DSS. Explicit knowledge is available to all without the requirement of a person who has to enable the access to the knowledge. (2) Tacit knowledge, on the other hand, is the uncodified knowledge possessed by individuals in the form of insights and experiences that only they can access and provide to the others. Tacit knowledge cannot be made explicit and explained to others or codified in text or systems. It is the knowledge that people know through practice or what they have learned over the years that cannot be verbalised. For example, recipes of exotic dishes are explicit knowledge that are codified in recipe books or on websites. Such knowledge is often only an indication of the tacit knowledge required to actually cook the dish. Tacit knowledge, in this case, would refer to how the materials have to be prepared, how the ingredients have to be added, what signs to look for to see if the dish is ready and so on. Tacit knowledge is often some things individuals may not even be aware of consciously – such as how a tennis player responds to a serve, something he does instinctively but may not be able to explain verbally. Or how a mechanic in a factory may know that something is wrong with the sound of a machine but may not be able to say why.

Knowledge is also categorised as either *expert* knowledge or *casual* knowledge. The difference between the two, for example, is the difference between the knowledge possessed by a surgeon performing open-heart surgery, and an individual tying a shoelace. The former requires years of training and practice to do competently, whereas the latter can be learned after a few tries. Both types of knowledge consist of tacit and explicit parts. The difference between expert and casual knowledge lies along a continuum, with states such as partial expert and novice in between. For example, computer programmers may be experts with many years of experience, specialists with a few years of experience, competent programmers or just beginners. Their levels of knowledge and understanding of the programming tasks will vary along an axis, with few experts at one end and possibly many beginners at the other.

Knowledge is also *contextual* and situational. Knowledge about how to operate a machine or use ERP software is grounded in the context of the organisation where the person has learned and acquired the knowledge. The person may transmit that knowledge to others, but the context has to be accounted for. To apply to another context, the knowledge has to be made abstract, or some principles have to be extracted from the context that can be applied elsewhere. For example, a person who has gained expertise in configuring an ERP package in one organisation has to apply the basic principles of such configuration in some other organisational context; the other organisation may have entirely different procedures and practices for which the principles will have to be applied.

13.4.1 Knowledge Life Cycle

Scientific knowledge about the world and nature are considered to be universal and unchanging. The theory of gravitation that explains how planets move and how stars

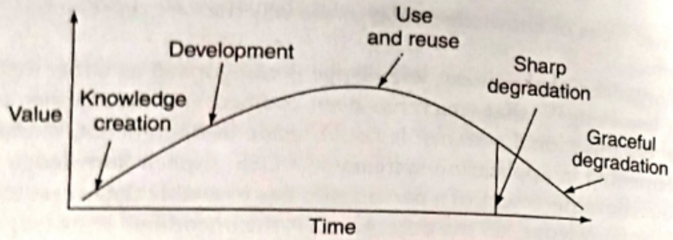


FIGURE 13.9 Value of knowledge.

change their positions in space has remained the same since its discovery (by Isaac Newton). Other scientific theories about the origins of the earth, the origins of life, the evolution of humans and so on, do have an unchanging character, but with the advancement of science some theories are replaced by others. For example, the nature of matter, based on particles, has constantly evolved, beginning with the theory of atoms and molecules to that of fundamental particles today. Knowledge, thus, has both invariant and varying parts.

Organisational knowledge, typically, has a life cycle in which it is created, developed, used and reused, and then it degrades and is replaced by other knowledge (see Fig. 13.9). The value of knowledge increases as it is created and developed. It is at a maximum when it is used and reused and begins to decline thereafter. Knowledge may degrade gracefully or sharply. *Knowledge creation* is the process of identifying and capturing knowledge. Within organisations, people may find that some knowledge is of value, identify what is to be captured, and then codify this knowledge or identify the person who has the knowledge. The codification or the act of 'person-to-documentation' transfer entails the person(s) having their insights encoded as text or as rules within a software application. This task may also entail upgrading knowledge encoded earlier to reflect newer variations and also the new context that may have emerged.

Knowledge development is the task of validating the knowledge to ensure that it is from an authentic source and is accurate. For example, knowledge about making changes to a particular manufacturing process, like machining, may require that engineers validate that the change is indeed from a reliable source (an expert) and also that the change will not disrupt existing methods. Knowledge development also entails preparing the knowledge for reuse. This will mean transferring the documents to searchable databases or creating templates or *frequently asked questions* (FAQ) documents to help people use the knowledge. Such development has to ensure the users are able to apply the knowledge to their special context, which may be different from the context in which the knowledge was created or captured.

Knowledge use and reuse refers to the tasks of applying the stored knowledge in situations where it is required. For example, users in an organisation may search a knowledge repository to find out how to create a Kiviat diagram with some data that they have collected. Knowledge about this may be stored in a document in which a user has used Kiviat diagrams to show data in a different context. Users will now have to interpret the manner in which Kiviat diagrams were created in the document and apply it to their own situation. The three important steps for using stored knowledge are: first search for and find the relevant knowledge, identify the abstract principles outside of the context of the knowledge, and then apply the principles to the current situation. Knowledge use and reuse can be facilitated by a person who has insight about the context and specific knowledge. Finding such a person becomes part of the first step, that is, search.

Knowledge *degrades* when its usefulness declines within the context in which it was created and captured. Degradation may be 'graceful' where the knowledge slowly becomes less useful, or may degrade suddenly. For example, knowledge about using a particular kind of hardware, say a pager, degrades slowly as people stop using pagers. However, knowledge about how to file taxes may degrade sharply owing to a change in tax laws.

The value of some forms of knowledge too has a life cycle. At the point of creation or capture of knowledge, the value is low as the organisation is not using the knowledge. At the point of development, the value increases as the knowledge has gained in credibility. When knowledge is being reused repeatedly, it has the highest value. As changes in the context and in the organisation erode the usefulness of knowledge, its value declines, either gracefully or sharply.

13.4.2 Strategies for Knowledge Management

13.4.2.1 *Identify Knowledge Needs*

Organisations have to identify what their knowledge needs are. Firms that are engaged in manufacturing need knowledge about advances in manufacturing processes, where to find better and cheaper materials, regulations regarding their industry, where to find skills and labour and so on. A service firm such as a hospital, for instance, will have different knowledge needs – what are the latest treatments for different kinds of diseases, who makes certain kinds of equipment and drugs, and from where can surgeons and other skilled personnel be hired. The needs will vary for each organisation based on their domain, their geographic location and their particular orientation.

It is essential for management to identify their key knowledge needs in different domains. The knowledge needed by the organisation usually belongs to two categories:

1. **Knowledge about the external environment:** It includes knowledge about competitors, the industry, government regulations, the economy and about innovations happening in the world.
2. **Knowledge about the internal workings of the organisation:** It refers to knowledge about how different things in the organisation are done and the facts relating to the organisation. In large organisations, people develop specialised knowledge about many things internal to the organisation that are not known to others. This knowledge is often the key to the efficiency of the organisation as a whole.

Having identified the knowledge needs of an organisation, management can organise the KM function in different ways.

13.4.2.2 *Hierarchic Approach*

In the hierarchic approach to KM, it is the top management that creates and sustains the KM infrastructure. Knowledge needs are identified for the different functions of the organisation. Experts and experienced persons are also identified, as the ones who will provide the key knowledge inputs. A method of selection and validating the knowledge inputs is put in place, as also information systems technologies that will enable the use and reuse of the knowledge.

Knowledge capture in such situations is done by codification and personalisation. Codification involves identifying the needed knowledge and its sources and then transferring the explicit portions into documents or text or system processes. Experts are consulted for this process and their knowledge is also codified. Care is also taken to ensure that the abstract rules are extracted from the knowledge while codifying so that it can be applied in different contexts. In the personalisation part, persons are identified and recognised as being most knowledgeable in a domain. Arrangements are made to enable users access the experts on a one-on-one basis when needed.

To maintain such an arrangement, the management has to ensure that sufficient incentives are provided to experts and key personnel for their time and efforts spent on knowledge management. Experts often have to be taken away from their work during the codification process, and also during one-on-one consultations, which has to be compensated adequately.

13.4.2.3 Market Approach

In a market approach to KM, the management is not centrally responsible for the KM effort. The management simply creates a set of enabling technologies and environments in which the knowledge is created and used by demand and supply conditions. For example, many firms allow employees to use e-mail list servers, personal web pages (or blogs) and wikis to communicate with others. Such media can become the platform for a KM market, as employees can post their 'demand' for some knowledge, and those who have the knowledge can post the 'supply'. There is no explicit effort on the part of managers to either induce people to ask or respond.

In a market model, there is no explicit coding process, nor a validating process. During reuse, there is no quality guarantee of the knowledge being recovered. There is also no assurance that the desired knowledge will be available. But market models work best to involve diverse people in different groups or functions. For example, a multinational firm used a market model to locate experts in different parts of the world. This could only happen when a demand for something specific, technical in nature, was posted, and someone from somewhere in the organisation saw the demand and responded to it.

A market model is sometimes supported by providing incentives to the most useful posts by any individual. This requires a mechanism by which users rate the knowledge provided, and the best rated ones get the rewards. This acts as a simple mechanism to encourage employees to devote their time and effort to helping others.

The market model does not work well in a fast-changing environment where context changes rapidly, and the degradation of knowledge is sharp. Markets also do not work well where search costs are high – where the effort required to find and answer is very high. Since the knowledge is not explicitly coded for a context and a situation, users find it hard to seek and understand the knowledge.

Despite the considerable effort put in by many organisations to manage knowledge effectively, there remain some challenges. One of the main challenge is that of incentives of employees to contribute. It is well known that employees have to compete with each other to rise in the corporate or organisational hierarchy. Much of the competitive advantage over co-employees comes from their superior knowledge about their work, which also leads to superior performance. When asked to share this knowledge with others, it leads to a contradiction at an individual level. If experts freely share their expert knowledge with whom they are competing for promotion, how will they have an advantage? This contradiction has led to many failed efforts at KM.

13.4.3 Technologies for Knowledge Management

13.4.3.1 *Expert Systems*

Expert systems are softwares that reflect reasoning by expert human beings. They are designed to capture the knowledge that expert humans have about certain domains. Once built, expert systems can be used by lay users as consultation systems, where they can respond to questions by users by querying their knowledge base. The systems can also explain their reasoning to the users, thus showing how a particular answer was arrived at.

Expert systems originated in the 1980s in the domain of medical systems. Researchers working in the discipline of artificial intelligence were keen to try and capture the expert knowledge that doctors gather over years of experience, and build it into computer software. In one of the pioneering efforts at Stanford University, a system known as Mycin was created. Mycin consisted of about 600 rules that captured the knowledge of doctors, particularly in the domain of identifying bacterial infections and prescribing antibiotics. Mycin was created by interviewing doctors over a period of many months to arrive at the rules. Rules are representation of the knowledge of the doctors. They are in the form of if-then statements that can be implemented in a computer program. An example of a Mycin rule is given below:

```
IF
1) The stain of the organism in grampos, and
2) The morphology of the organism is COCCUS, and
3) The growth confirmation of the organisms chains
THEN
There is suggestive evidence (0.7) that the identity of
the organism is streptococus.
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With such a rule, the expert system can inquire about the parameters such as the 'stain' and morphology from the user, and establish the presence of 'organism chains' and then make a recommendation about the identity of the organism. In combination with other rules, the system could make very sophisticated diagnosis. When evaluated against human doctors, Mycin performed very well.

Expert systems were subsequently developed for many applications such as drilling for oil, loan processing, shop-floor scheduling, mortgage evaluation, process control of machines, combining of chemical compounds and many others. The crucial requirement for expert systems is having a human expert who can be queried and modelled.

13.4.3.2 Content Management Systems

Content management systems (CMS) are used to store all types of files within organisations. Such systems are typically designed to be used through a browser and allow many individuals and groups to both deposit and retrieve documents and files. A typical CMS consists of a database with a front end that allows access to users. Files stored on the CMS could be of any type – unstructured text documents, word-processed documents, audio or video files, links to websites and other software. Some CMS allow *workflows* to be implemented. Workflows are sets of permissions given to some files that allow the file or document to be seen and modified by people in a pre-specified order.

CMS are typically used as repositories of codified knowledge. They allow users to easily search through the files as also add comments to and rate particular items. Within some universities, for instance, CMS are used to store all the reading materials, grades, student homework, student files and other material related to education. Such CMS are also referred to as learning management systems.

13.4.3.3 Mind Maps

Mind maps are diagrams that have a central idea as a node in the middle, around which are links to related ideas, concepts, themes, objects, files, text and so on. A mind map can be made collaboratively to capture knowledge about processes or phenomena. Participating users can add to the mind map details about what they know and also sources from where knowledge can be obtained.

There are many software tools available that allow mind maps to be created in a collaborative mode. Most tools are available on a web server or in the cloud through a web browser. The beginning of this chapter (and all the chapters in this book) has a mind map of the theme and related concepts covered in this chapter.

Chapter Glossary

Intelligence The phase of problem solving and decision making where the person seeks information about the problem.

Design The phase of decision making where the person determines the criteria by which to find the best solution.

Choice The third phase of decision making where the person uses the criteria to select the solution out of many available.

Bounded rationality The idea that humans can consider only a certain number of criteria and a restricted number of options to make decisions.

Structured decisions A situation in which the criteria, the data needed for the problem and the method by which to make a decision are known.

Unstructured decisions A situation in which there are no clear parameters or criteria by which to make a decision, and what data to use is also not precisely known.

Analytics Techniques by which complex models are applied to large collections of data available within organisations to solve problems and seek insights.

Predictive analytics Techniques that use past data to predict future trends and scenarios.

Real-time analytics Using modelling techniques to monitor activities within the organisation, using transaction data.

Dashboard A set of graphical displays that show certain parameters in a real-time manner.

Neural networks A mathematical model of the brain that is used to assist with solving problems of classification and prediction.

Classification Techniques by which data on objects and transactions are categorised into groups.

Prediction Techniques by which historical data are used to forecast future data.

Decision trees A technique by which a hierarchy of classifications is created.

Clustering Techniques by which natural groupings and aggregations are revealed in data.

Data visualisation Techniques by which data properties are displayed graphically.

Declarative knowledge Knowledge about factual matters.

Procedural knowledge Knowledge about how things are done.

Explicit knowledge Knowledge that is codified in text or some other tangible manner.

Tacit knowledge Knowledge that is known to humans in the form of insights and experiences, and that cannot be easily verbalised.

Expert knowledge Knowledge possessed by humans who have extensive experience in a domain.

Contextual knowledge Knowledge that is specific to a situation or a location.

Knowledge creation The task of explicitly encoding knowledge or recording who has the knowledge.

Knowledge development The task of validating and verifying the knowledge to ensure it is from an authentic source and is accurate.

Knowledge use The act by which organisational knowledge is applied in situations where it is required.

Knowledge degradation The process by which knowledge becomes less useful in a given context.

Expert systems Systems that encode human knowledge and reasoning in a set of rules, pertaining to a domain, which can be applied to solve problems in the same domain.

Content management systems A system used to store and retrieve documents. The documents may be stored and accessed by any group within or outside the organisation.

Mind maps Diagrams that depict a central node around which are arranged, through links, related ideas, concepts and themes. These diagrams can be created and shared by a group.

Review Questions

1. What is a DSS and how can it help managers?
2. What is the difference between an MIS and a DSS?
3. What are the phases of decision making? In which phase can DSS be most helpful?
4. What is a structured decision? Explain with an example.
5. What is an unstructured decision?
6. What are the main components of a DSS? What are their roles?
7. What is predictive analytics? Give one example.
8. How are neural networks used for predictive analytics?
9. What is a decision tree?
10. What is the technique of clustering used for?
11. What is knowledge management (KM)? Why do organisations use KM?
12. What is the difference between declarative and procedural knowledge? Give examples of each.

13. What is the difference between explicit and tacit knowledge? Give examples of each.
14. What is expert knowledge?
15. Describe the knowledge life cycle?
16. In what ways does knowledge degrade?
17. What is the advantage of the hierarchic approach to KM over the market approach?
18. Why do KM efforts fail?
19. How is knowledge captured in an Expert System?

Research Questions

1. Give an example of a decision that requires considering many parameters and many choices. How does bounded rationality play a role in this?
2. Draw a decision tree for the decisions you make to choose a restaurant to go to. You could use parameters such as 'reputation of restaurant,' 'type of food,' 'price' and 'distance from home.'
3. Visit a local firm and talk to an experienced person within the firm who is working on a problem or a project. Identify the rules that he/she follows to solve problems, such as the rules mentioned in the section on Expert Systems.

Case Question

Why did the management of the Taj Hotels resort to revenue optimisation? What problem did they need assistance with?

Further Reading

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