UNIT 4 BUSINESS VALUES OF INFORMATION SYSTEM

Structure **Page No.**

4.0 INTRODUCTION

In this unit, we will briefly discuss the impact information systems have on business, organisations and individuals. It is a well-realised fact that despite the ever-increasing importance of the information resource, evaluating the actual benefits of using information systems remains problematic. Nevertheless, due to cost and time factors involved in designing and implementing information systems, it is essential to work out cost benefit analysis and total cost of owning the system. We will be discussing these as well as the Empirical studies which have been getting due recognition due to the human angle involved in the information systems implementation. The cultural considerations are the other important factor in information systems implementation which will be discussed here.

Decision making, Decision management and Decision support systems constitute one of the areas which has been influenced by the information systems and this topic will also be covered in this unit.

4.1 OBJECTIVES

After going through this unit, you should be able to:

- understand the business value of an information system and evaluate the business value of information systems;
- assess impact of culture and human angle requirements for Information system implementation, and
- appreciate the importance of decision making and use of decision support systems.

4.2 IMPACT OF INFORMATION SYSTEMS

Information systems play a role in almost every field of activity in the modern world. They have a major effect on businesses and organisations; they even have a deep impact on our private lives and our culture. Information is an organisational resource and it is a very important production source in information-based industries and services (e.g., banking).

The role of business information systems has changed and expanded over the last four decades. In the incipient decade (1950-1960) it started with calculator (bookkeeping;

Texas Instruments, HP) and moved on to computers (accounting, payroll; mainframe, mini (IBM)). However, computers could be afforded during that period by only the largest organisations. They were used to record and store bookkeeping data such as journal entries and specialised journals. These were used to generate a **limited range of predefined reports, including income statements, balance sheets and sales reports.** They were trying to perform a decision-making support role, but they were not up to the task.

By the 1970s **"Management Information system and decision support systems"** were introduced. They were interactive in the sense that they allowed the user to choose between numerous options and configurations. Not only was the user allowed to customize outputs; they also could configure the programs to their specific needs. There was a cost though. As part of the mainframe leasing agreement, it was possible to have an IBM system developer permanently on site by paying.

The main development in the 1980s was the introduction of **decentralised computing**. Instead of having one large mainframe computer for the entire enterprise, numerous PCs were spread around the organisation. This meant that instead of submitting a job to the computer department for batch processing and waiting for the experts to perform the procedure, each user had has/her own computer that could be customize for their own purposes. People who used these systems and struggled with DOS protocols, BIOS functions, and DOS batch programming during that period, tell their stories with pride.

As people became comfortable with their new skills, they discovered all the things their system was capable of. Computers, instead of creating a paperless society, as was expected, produced mountains of paper, most of it of no value. Mounds of reports were generated just because it was possible to do so. This information overload was mitigated somewhat in the 1980s with the introduction of **"executive information systems"**. They streamlined the process, giving the executive exactly what s/he wanted, and only what was wanted.

The 1980s also saw the first commercial application of artificial intelligence techniques in the form of **"expert systems"**. These programs could give advice within a very limited subject area. The promise of decision making support, first attempted in management information systems back in the 1960s, had step-by-step, come to fruition.

The 1990s saw the introduction of the Communicators (e-mail, document management; networks; Microsoft, Cisco) and *Strategic information system*. These systems used information technology to enable the concepts of business strategy.

The role of business information systems had now expanded to include strategic support. The latest step was the commercialization of the Internet, and the growth of intranets and extranets at the turn of the century.

All indications are that e-commerce will continue to grow in the coming years. e-commerce, or the use of the internet and the web to conduct business, is typically categorised into business-to-consumer (B2C), business-to-business (B2B), and intra-organisational e-business. Businesses, governments, and nonprofit organisations are increasingly investing in information technology (IT) infrastructures to be able to conduct digitally enabled transactions. Online shoppers, constituting the B2C segment, spent a record Rs.782 billion during the year 2005, according to Research Giant Nielsen / ComScore, representing a 24 percent increase from 2004. While we have witnessed promising growth in the B2C area, there is a tremendous opportunity for generating business value from B2B e-commerce. Moreover, a few traditional businesses, Dell, and Wal-Mart, have been successful in integrating e-commerce into their traditional business models. However, many other companies still struggle with implementing and justifying e-commerce initiatives. Managers primarily worry about falling behind in the implementation of e-commerce initiatives, yet the business value of these initiatives needs justification. The evidence on both the success and failure of such initiatives has been generally anecdotal. This calls for rigorous empirical research examining the payoff realised from e-commerce initiatives.

In the twenty first century scenario, another aspect having deep impact is convergence and Integration of Devices – Partners (personal digital assistants, software agents, SMS, Microsoft SOAP, mobile appliances (*Figures 1* and *2*)

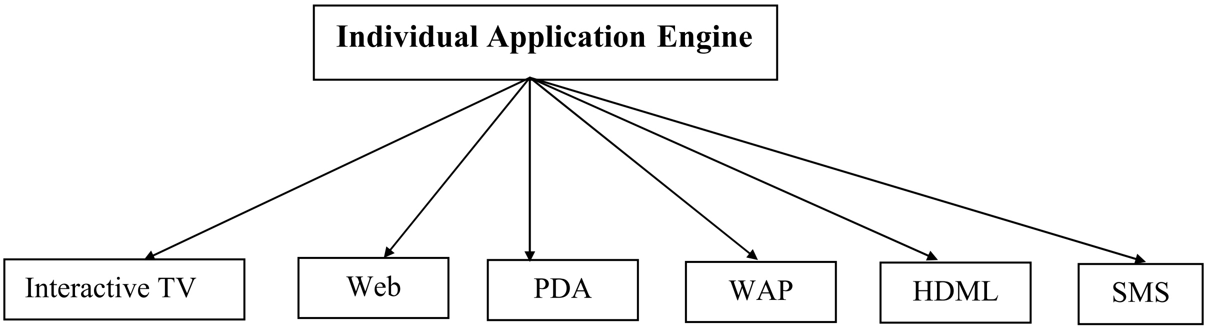

Figure 1: Various information communication devices

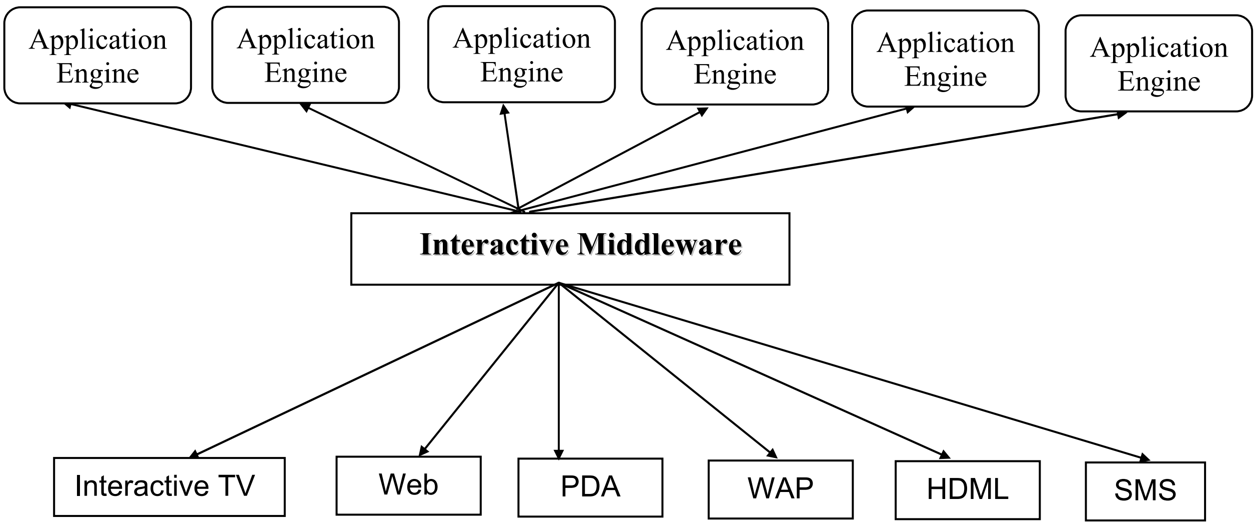

Figure 2: Convergence of various communications devices

With all these developments the **impact of the Information Systems** is that at present expectations have shifted towards Now Economy and Integrated Economy.

a) "**Now economy**", a real-time enterprise – organisation that is expected to react instantaneously to changes in its business. To provide "instant gratification" to customers, products and services to be delivered to customers: Anytime (24/7), anywhere (global reach), any form (mass customisation), any price (dynamic pricing depending on real-time supply-demand adjustment). This will require Real-time Monitoring, Reporting and Decision-making.

b) "**Integrated economy**" – suppliers, customers, affinity groups, and competitors. We may in due course of time observe all the mega-mergers and alliances and mass marketing being slowly replaced by molecular marketing with specific customer groups. Businesses have already started moving outside the boundaries of countries. Business Process Outsourcing across countries is already a reality.

Social Global Impact of Information Systems

Information technology is not the cause of the changes we are living through. But without new information and communication technologies none of what is changing our lives would be possible. In the 1990s the entire planet is organised around telecommunicated networks of computers at the heart of *information systems* and communication processes. The entire realm of human activity depends on the power of information, in a sequence of technological innovation that accelerates its pace by month. Genetic engineering, benefiting from this wealth of information processing capacity, is progressing by leaps and bounds, and is enabling us, for the first time, to unveil the secrets of living matter and to manipulate life, with extraordinary potential consequences. Software development is making possible user-friendly computing, so that millions of children, when provided with adequate education, can progress in their knowledge, and in their ability to create wealth and enjoy it wisely, much faster than any previous generation. Internet today used by about 100 million people, and doubling this number every year, is a channel of universal communication where interests and values of all sorts coexist, in a creative cacophony. Certainly, the diffusion of information and communication technology is uneven. Most of Africa is being left in a technological apartheid, and the same could be said of many other regions of the world.

Technology *per se* does not solve social problems. But the availability and use of information and communication technologies are a pre-requisite for economic and social development in our world. *They are the functional equivalent of electricity in the industrial era.* Econometric studies show the close statistical relationship between diffusion of information technology, productivity and competitiveness for countries, regions, industries and firms. They also show that an adequate level of education in general and of technical education in particular, is essential for the design and productive use of new technologies. But neither the sheer number of scientists and engineers nor the acquisition of advanced technology can be a factor of development by itself without an appropriate organisational environment.

The crucial role of information and communication technologies in stimulating development is a two-edged sword. On the one hand, it allows countries to leapfrog stages of economic growth by being able to modernize their production systems and increase their competitiveness faster than in the past. The most critical example is that of the Asian Pacific economies, and particularly the cases of Hong Kong, Taiwan, Singapore, Malaysia and South Korea. This is so despite the current financial crisis, which is unrelated to competitive performance and may be related, in fact, to the attractiveness of booming Asian economies to global capital flows. On the other hand, for those economies that are unable to adapt to the new technological system, their retardation becomes cumulative. Furthermore, the ability to move into the Information Age depends on the capacity of the whole society to be educated, and to be able to assimilate and process complex information. This starts with the education system, from the bottom up, from the primary school to the university. It relates, as well, to the overall process of cultural development, including the level of functional literacy, the content of the media, and the diffusion of information within the population as a whole.

In this regard, what is happening is that regions and firms that concentrate the most advanced production and management systems are increasingly attracting talent from around the world, while leaving aside a significant fraction of their own population whose educational level and cultural/technical skills do not fit the requirements of the new production system. A case in point is Silicon Valley the most advanced information technology-producing region in the world, which can only maintain the pace of innovation by recruiting every year thousands of engineers and scientists from India, China, Taiwan, Singapore, Korea, Israel, Russia and Western Europe, to jobs that cannot be filled by Americans because they do not have proper skills. Similarly, in Bangalore, Mumbai, Seoul or Campinas, engineers and scientists concentrate in high-technology hubs, connected to the Silicon Valleys of the world, while a large share of the population in all countries remains in low-end, low-skill jobs, when they are lucky enough to be employed at all. Thus, there is little chance for a country, or region, to develop in the new economy without its incorporation into the technological system of the information age.

In sum, information and communication technology is the essential tool for economic development and material well-being in our age; it conditions power, knowledge and creativity; it is, for the time being, unevenly distributed within countries and between countries; and it requires, for the full realisation of its developmental value, an inter-related system of flexible organisations and information-oriented institutions. In a nutshell, cultural and educational development conditions technological development, which conditions economic development, which in turn conditions social development, and this stimulates cultural and educational development once more. This can be a vicious circle of development or a downward spiral of underdevelopment. The direction of the process will not be decided by technology but by society, through its conflictive dynamics.

The IT executive must meet these challenges head-on, contending with an environment where businesses are more interconnected and network-enabled than ever before, and information system capabilities will determine the success and failure of core business capabilities. **Today's technology executives must manage risk and ensure that their IT initiatives and investments deliver**:

- The **high availability** and **performance** required meeting the needs of the global business environment, ensuring that transactions are processed with utmost reliability and security;
- Collaboration between disparate and geographically dispersed development teams around the globe;
- The foresight and capability to support emerging technology initiatives such as service-oriented architectures (SOA).

4.3 EMPIRICAL STUDIES

While empirical studies in software engineering are beginning to gain recognition in the research community, this sub area is also entering a new level of maturity by beginning to address the human aspects of software development. This added focus has added a new layer of complexity to an already challenging area of research. Along with new research questions, new research methods are needed to study non- technical aspects of software engineering. In many other disciplines, qualitative research methods have been developed and are commonly used to handle the complexity of issues involving human behaviour.

While empirical evaluations are a common research method in some areas of Information systems like, Artificial Intelligence (AI), others still neglect this approach. Here we will be discussing advantages, opportunities, and limits of empirical evaluations outlining both the opportunities and the limits of empirical evaluations for IS / AI techniques with the examples of the evaluation of adaptive systems. Using the so called layered evaluation approach, we will demonstrate that empirical evaluations are able to identify errors in IS / AI systems that would otherwise remain undiscovered.

1) Advantages: Why Evaluations are Needed

Some areas of IS / AI apply empirical methods regularly, e.g., planning and search algorithms are benchmarked in standard domains, and machine learning algorithms are usually tested with real data sets. However, looking at some applied areas such as user modeling, empirical studies are rare, e.g., only a quarter of the articles published in *User Modeling and User Adapted Interaction* (UMUAI) are reporting significant empirical evaluations. Many of them include a simple evaluation study with small sample sizes and often without any statistical methods.

On the other hand, for an estimation of the effectiveness, efficiency, and the usability of a system that applies IS / AI techniques in real world scenarios, empirical research is absolutely necessary. Especially user modeling techniques which are based on human-computer interaction require empirical evaluations. Otherwise, as we are going to demonstrate, certain types of errors will remain undiscovered. Undoubtedly, verification, formal correctness, and tests are important methods for software engineering; however, we state that empirical evaluation — seen as an important complement — can improve IS / AI techniques considerably. Moreover, the empirical approach is an important way to both, legitimise the efforts spent, and to give evidence to the usefulness of an approach.

2) Opportunities: What we may learn from Empirical Evaluations

Empirical methods for IS / AI should answer three basic research questions:

- How will a change in the agent's structure affect its behaviour given a task and an environment?
- How will a change in an agent's task affect its behaviour in a particular environment?
- How will a change in an agent's environment affect its basic behaviour on a particular task?

These questions may be answered by a combination of four kinds of empirical studies: *exploratory studies* that yield causal hypotheses; *assessment studies* that establish baselines, ranges, and *benchmarks*; manipulation experiments to test hypotheses about causal influences; and finally *observation experiments* (or quasi-experiments) that disclose effects of factors on measured variables without random assignment of treatments.

These general and goal defining questions have to be specified in terms of each IS/ AI area. As an illustrative example, we outline the opportunities of empirical evaluations for adaptive systems and user modeling. Similar results can be obtained for other IS / AI systems.

The evaluation of adaptive systems can be seen as a layered process where each evaluation layer is a prerequisite for the subsequent layers. Three approaches have been proposed that basically just differ in layer granularity. Thus, we will outline four layers of evaluation of adaptive systems here.
Figure 3 shows the four layers: During interaction the adaptive system observes the user and registers certain events or behaviour cues. (1) Based on these input data abstract user properties are inferred, (2) Finally the system decides what and how to adapt, (3) presents the adapted interface to the user, (4) Each layer has to be evaluated to guarantee adaptation success.

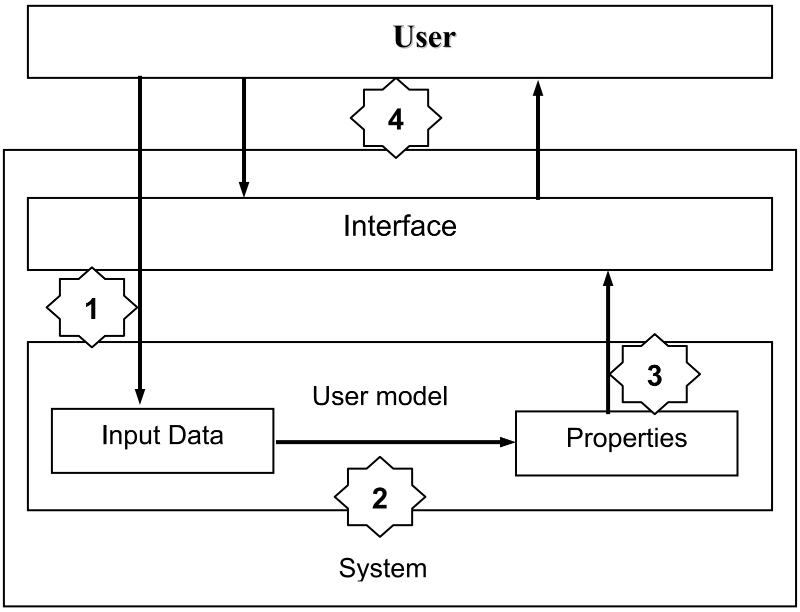

Figure 3: Four layers for the evaluation of adaptive systems

2.1 Evaluation of Reliability and Validity of Input Data

The first layer evaluates the reliability and the external validity of input data. Unreliable input data would result in mis-adaptations. If input data turns out to be unreliable, further inferences might be distorted or even impossible

Layered Evaluation: The Layered Evaluation approach defines several abstract data processing steps within adaptive systems that have to be evaluated in order to guarantee adaptivity success. The evaluation is conducted in layers which mean that a successful evaluation of a previous layer is prerequisite for the subsequent layers, e.g., only if the user properties have been inferred correctly it is possible to evaluate different adaptation decisions, because the adaptation decision relies on the user properties

Objectivity, Reliability, Validity: The quality of observed data may be described in terms of three quality measures. Proper observations are independent of the observer (objectivity), are not biased or distorted by the observation method (reliability), and measure exactly the variable that was intended (validity). As adaptive systems *observe* the user these quality measures are relevant for empirical evaluation.

2.2 Evaluation of Inference

By evaluating the system's inference it is possible to test the inference mechanism in different environments under real world conditions.

Three kinds of studies are used to evaluate the inference. First, exploratory studies can provide empirical grounds for the agent's structure. Second, simulations with hypothetical users can prove that certain combinations of input data are processed as expected. Third, in classical experimental settings it is possible to compare the inferences of the system with the real world.

2.3 Evaluation of Adaptation Decision

Even if a system has inferred some user properties there are usually several adaptation possibilities left. Comparing different adaptation decisions (possibly including non-adaptation) estimates the effects of adaptation and may prove the chosen decision to be the most successful. e.g., on comparing four different adaptation methods in an adaptive learning system. Each method considered the same user properties but adapted the interface in a different way (i.e., with / without adaptive guiding and with / without link annotation).

2.4 Evaluation of Interaction

The previous layers may show that the system is consistent and infers correct user properties. However, adaptation might still be unsuccessful because users become confused or dissatisfied. Thus, the human-system interaction has to be evaluated as well. Both, objective and subjective measures are relevant. e.g., users might rate the system's usability or the solution quality. Examples of objective criteria for interaction quality include frequency of task success and number of required hints.

The examples above emphasize the necessity of empirical evaluations in each of the four layers. It is impossible to detect certain kinds of mis-adaptations that result from biased input data, false inferences, or inadequate adaptation decisions, except for testing the system or parts of the system with real users. Especially usability issues highly depend on empirical research.

3) Limits: Where Empirical Evaluations fail

Empirical research offers many opportunities; however, there are at least two kinds of limitations: on the one hand, errors and pitfalls that are directly related to the layered evaluation approach, and, on the other hand, inherent limitations of empirical research in general.

3.1 General Problems of Empirical Research

Obviously, empirical studies are not a formal proof of a fact. They rather yield, support, or reject hypotheses. However, the results are always afflicted with uncertainty, which can often be expressed in a statistical probability value. Furthermore, for most statistical tests confidence intervals, test power, and effect sizes are available which should be reported as well.

This hypothesis testing procedure is responsible for an important limitation of empirical research. Empirical studies are very good at identifying design errors and wrong assumptions but they do not suggest new theories or approaches directly. Even an explorative study requires some hypotheses about possible impact factors. Thus, empirical evaluations have to be combined with theoretical grounds to yield useful results.

Not really a limitation but a structural reason why evaluations are currently ignored is the fact that evaluations are not required for publication at international conferences or journals (at least in terms of user modeling). Thus, the empirical part is often scheduled for the end of a project and finally skipped due to lack of time. If publishers and reviewers would demand empirical evaluations it would soon be an integrated part of research where empirical and theoretical components could stimulate each other. Moreover, AI systems are usually implemented by computer scientists who tend to be less familiar with empirical methods than people with training in human-computer interaction.

When evaluating adaptive systems — as opposed to IS / AI systems in general — at least two additional problems emerge: first, defining adequate control groups is difficult for those systems that either cannot switch off the adaptivity, or where a non-adaptive version appears to be absurd because adaptivity is an inherent feature of these systems. Comparing alternative adaptation decisions might relieve this situation in many cases, as this allows to estimate the effect size that can be traced back to the adaptivity itself, but the underlying problem remains: What is a fair comparison condition for adaptive systems.

Second, adequate criteria for adaptivity success are not well defined or commonly accepted: on the one hand, objective standard criteria (e.g., duration, number of interaction steps, knowledge gain) regularly failed to find a difference between adaptive and non-adaptive versions of a system. Usually, these criteria have not been proved to be valid indicators of interaction quality or adaptivity success. On the other hand, subjective criteria that are standard in human-computer interaction research (e.g., usability questionnaires, eye tracking) have been applied to user modeling very rarely. Probably, the effects of adaptivity in most systems are rather subtle and require precise measurement. Recently, a new criterion called behavioural complexity has been proposed that has been designed especially for adaptivity effects but there is still much more work to be done on criteria validation.

3.2 Pitfalls and Errors Uncovered by the Layered Evaluation Approach

Keeping the above factors in mind, we have to note that there are still several pitfalls that have to be circumvented when conducting evaluations in the different layers.

The evaluation of the reliability of input data relies heavily on a properly selected sample of participants, because retest-reliability and split-half reliability require a sufficient amount of variance in the observed variables. Furthermore, sample selection, sample size, and randomisation are important for the subsequent layers as well. Generalised statements about the inference mechanism are possible only if the observed effect is supposed not to be an artifact of a sample bias.

The evaluation of inference will not allow for statements about every possible case including extreme values and special cases as a formal proof would. It will rather test the inference mechanism for external validity and feasibility under real world conditions.

When comparing different adaptation decisions it is possible to select the best one in reference to several criteria. However, there might be unknown or unaccounted adaptation decisions that are even better, because the empirical approach compares of course existing versions only. It might be possible to escape from this limitation by using a human inference mechanism in a so called Wizard of Oz design (or similar approaches) as an additional control condition, because this might account as a benchmark of what adaptation might accomplish in this situation at all. However, this method is applicable only for those kinds of systems where humans are actually able to take over the inference processes, as opposed to systems that deal with large amounts of information or complex inferences.

The evaluation of interaction highly depends on a precise and transparent goal setting. Interaction quality can be defined in many different ways, and thus, the result of such an evaluation will never be that “system A is better than system B in general”, but only “better in terms of goal X or goal Y”.

4) Summary and Future Perspectives

It has been realised that empirical research offers a lot of opportunities that could inspire current research in IS/AI in general and in particular in user modeling. Empirical studies are able to identify errors in AI systems that would otherwise remain undiscovered. However, it has been largely neglected so far.

In order to encourage new empirical evaluations of adaptive systems online database is available to researchers. This online database contains studies that are concerned with the evaluation of adaptive systems. Each study is categorised in terms of the layer that is evaluated, the criteria that have been used, the function and the adaptation method of the evaluated system(s), statistical methods, and many more dimensions. Researchers who want to evaluate their system get hints about useful criteria that did (or did not) work in previous studies. Proposals of experimental designs and evaluation strategies simplify the planning process.

Moreover, an online database could serve as reference for the usefulness of certain inference mechanisms and adaptivity in general. To provide a really useful service to the community, the number of registered studies should be expanded considerably. Thus, online database offers an online interface for study submission and everybody is invited to enhance such databases with new studies.

4.4 COST VALUE PERFORMANCE

Investing in information systems can **pay off** for a company in many ways.

1) Such an investment can support a **core competency**. Great companies invariably have one or two core competencies, something they can do better than anyone else. This could be anything from new product development to customer service. It is the heart of the business and no matter what it is, information technology can support that core competency. An IT investment in a company's core competency can create a significant barrier to entry for other companies, defending the organisation's primary turf and protecting its markets and profits.

2) It can build supply chain networks. Firms that are a part of an integrated supply chain system have established relationships of trust with suppliers. This means faster delivery times, problem-free delivery and an assured supply. It can also mean price discounts and other preferential treatment. The inability of new entrants to get onto a supply chain / inventory management system can be a major barrier to entry.

3) It can enhance distribution channel management. As with supplier networks, investment in distribution channel management systems can ensure quicker delivery times, problem free delivery, and preferential treatments. When the distribution channel management system is exclusive, it can mean some control over access to retailers, and, once more, a barrier to entry.

4) Such an IT investment can help build brand equity. To build a brand, firms often invest huge sums in advertising. A huge brand name is a formidable barrier to enter and sustaining it can be facilitated by investment in marketing information systems and customer relationship management system.

5) Information systems can mean better production processes. Such systems have become essential in managing large production runs. Automated systems are the most cost efficient way to organise large-scale production. These can produce economies of scale in promotion, purchasing, and production; economies of scope in distribution and promotion; reduced overhead allocation per unit; and shorter break-even times more easily. This absolute cost advantage can mean greater profits and revenue.

6) IT investment can boost production processes. Information systems allow company flexibility in its output level it is claimed that economies of scale are a barrier to entry, aside from the absolute cost advantages they provide. This is because, a company producing at a point on the long-run average cost curve where economies of scale exist, has the potential to obtain cost savings in the future, and this potential is a barrier to entry.

7) Implementing IT experience can leverage learning curve advantages. As a company gains experience using IT systems, it becomes familiar with a set of best practices that are more or less known to other firms in the industry. Firms outside the industry are generally not familiar with the industry-specific aspects

of using these systems. New entrants will be at a disadvantage unless they can redefine the industry's best practices and leapfrog existing firms.

8) IT investment can impact mass customisation production processes. IT controlled production technology can facilitate collaborative, adaptive, transparent, or cosmetic customisation. This flexibility can increase margins and increase customer satisfaction.

9) Leverage IT investment in computer-aided design. CAD systems facilitate the speedy development and introduction of new products. This can create proprietary product differences. Product differentiation can be a barrier to entry. Proprietary product differences can be used to create incompatibilities between competing products. These incompatibilities increase consumers' switching costs. High customer switching costs is a very valuable barrier to entry.

10) It means expanded E-commerce. Company web sites can be personalized to each customer's interests, expectations, and commercial needs. They can also be used to create a sense of community. Both of these tend to increase customer loyalty. Customer loyalty is an important barrier to entry.

11) Information systems leverage stability. Technologically sophisticated firms with multiple electronic points of contact with customers, suppliers, and others enjoy greater stability. This monumental appearance of stability can be a barrier to entry, especially in financial services.

The simple fact that IT investment takes a significant amount of money makes it a barrier to entry. Anything that increases capital requirements is a barrier to entry. The successful Information System implementation is a challenge, as it has to meet a number of critical business goals: deliver increasingly complex mission-critical business applications quickly and securely, and ensure that core business operations are strongly supported. Availability is critical as poorly performing applications have an immediate business impact, cutting revenue and alienating customers. These challenges must be met within the constraints of tight IT budgets and scarce internal corporate resources, while the external environment breeds new technology developments that determine how the enterprise derives competitive advantage. Therefore, evaluation of a system to ensure that it will meet the desired goals, before taking up its implementation, is necessary.

Traditional Financial Evaluation Procedures

For any capital investment almost all organisations carry out financial evaluation to ascertain the financial viability of the project or, in other words, any financial investment is taken up only if, as per this analysis value addition is expected.

Capital planning, also known as "**capital budgeting"**, is an accounting process used to determine a firm's long-term investments such as new machinery, replacement machinery, new plants, new products, new information system and research and development projects. As part of this process a financial analyst determines the economic value of business projects / ventures and allocates capital to those endeavours which present the greatest calculated return on investment.
All capital budgeting methods rely on measures of cash flows into and out of the company. The investment cost is an immediate cash outflow caused by the purchase of the capital item. In subsequent years, the investment may cause additional outflows that will be balanced by the cash inflows resulting from the investments. Cash inflows may come from increased sales, higher realisation due to better quality of the product or better market share or reduced cost of the products. The difference between the cash outflows and cash inflows is used for calculating the financial worth of the project.

Once the cash flows have been established, several alternative methods are available for comparing different projects and deciding about the investment.

Financial models assume that all relevant alternatives have been examined, that all costs and benefits are known, and that these costs and benefits can be expressed in terms of money. When one has to choose among many complex alternatives, these assumptions are rarely met in the real world, although they may be approximated. Some of the common costs and benefits are listed in the *Table 1*.

Table 1: Costs and Benefits of Information System Implementation

Costs	**Benefits (Intangible)**
Hardware	Improved operations
Software	Better asset utilization
Infrastructure (Networking, telecommunications)	Better resource control
Services	Better organisational planning
Manpower	Higher organisational flexibility
	Improved quality of information
Benefits (Tangible)	More Timely information
Lower operational costs	Better Employee training
Increased productivity	Better employee morale
Reduced manpower	Better corporate image
Lower computer expenses	Improved decision making
Lower vendor services cost	Higher employee cooperation
Lower clerical overheads	Better customer satisfaction
Reduced facility maintenance cost	Better environmental compliance
Higher sales volume	Better legal compliance

Popular methods for determining the relative and absolute value of business projects / ventures include: *Net Present Value (NPV), Internal Rate of Return (IRR), Discounted Cash Flow (DCF),* and *Payback Period.*

Net present value (or NPV) is a standard method in finance for capital budgeting – the planning of long-term investments. Using the NPV method a potential investment project should be undertaken if the present value of all cash inflows minus the present value of all cash outflows (which equals the net present value) is greater than zero.

A key input into this process is the interest rate or "discount rate" which is used to discount future cash flows to their present values. If the discount rate is equal to the shareholder's required rate of return, any NPV > 0 means that the required return has been exceeded, and the shareholders will expect an additional profit that has a present value equal to the NPV. Thus, if the goal of the corporation is to maximize shareholders' wealth, managers should undertake all projects that have an NPV > 0, or if two projects are mutually exclusive, they should choose the one with the highest positive NPV.

Net present value - Example

X Corporation must decide whether on not to introduce a new information system or product line. The new information system or product will have startup costs, operational costs, and incoming cash flows over six years. This project will have an immediate (t = 0) cash outflow of Rs.100,000 (which might include hardware, and employee training costs). Other cash outflows for years 1-6 are expected to be Rs. 5,000 per year. Cash inflows are expected to be Rs. 30,000 per year for years 1-6. All cash flows are after-tax, and there are no cash flows expected after year 6. The required rate of return is 10%. The present value (PV) can be calculated for each year:

T=0 –Rs. 100,000 / 1.10^0 = – Rs. 100,000 PV.
T=1 (Rs. 30,000 – Rs. 5,000)/ 1.10^1 = Rs. 22,727 PV.
T=2 (Rs. 30,000 – Rs. 5,000)/ 1.10^2 = Rs. 20,661 PV.
T=3 (Rs. 30,000 – Rs. 5,000)/ 1.10^3 = Rs. 18,783 PV.
T=4 (Rs. 30,000 – Rs. 5,000)/ 1.10^4 = Rs. 17,075 PV.
T=5 (Rs. 30,000 – Rs. 5,000)/ 1.10^5 = Rs. 15,523 PV.
T=6 (Rs. 30,000 – Rs. 5,000)/ 1.10^6 = Rs. 14,112 PV.

The sum of all these present values is the net present value, which equals Rs. 8,882. Since the NPV is greater than zero, the corporation should invest in the project.

More realistic problems would need to consider other factors, generally including the calculation of taxes, uneven cash flows, and salvage values.

Net present value - Formula

Net Present Value can thus be calculated by the following formula, where *t* is the amount of time (usually in years) that cash has been invested in the project, *N* the total length of the project (in this case, five years), *i* the cost of capital and *C* the cash flow at that point in time.

$$\text{NPV} = \sum_{t=0}^{N} \frac{Ct}{(1+i)^t}$$

if the only cash outflow is the initial investment, then the formula may be written:

$$NPV = \sum_{t=1}^{N} \frac{Ct}{(1+i)^t} - Initial\ Investment$$

The above example is based on a constant rate being used for future interest rate predictions and works very well for small amounts of money or short time horizons. Any calculations which involve large amounts or protracted time spans will use a yield curve to give different rates for the various time points on the calculation. So, the rate for 1 year may be 10% - the (money market) rate while the rate for 2 years may be 11% and that for 3 years 11.5%, and so on.

Internal rate of return (IRR)

The internal rate of return (IRR) is defined as the discount rate that gives a net present value (NPV) of zero. The NPV is calculated from an annualized cash flow by discounting all future amounts to the present.

Example:

Year	Cash flow
0	–100
1	+120

Calculation of NPV:

i = interest rate in per cent
NPV = –100 +120/[(1+i/100)^1]
(This calculation is condensed; as the detailed calculation has already been explained above.)

Calculation of IRR (in per cent):

NPV = 0
–100 +120/[(1+IRR/100)^1] = 0
IRR = 20

As an investment decision tool, the calculated IRR is used to rate alternative investments. The investment alternative with the highest IRR is preferred. Note that placing the initial investment amount in the bank is always an alternative. Thus, any investments that do not match the banks going deposit rate will not be realised.

It should also be noted that zeros of NPV as a function of IRR may lack existence or uniqueness if there is some alternation of positive and negative cash flow. The IRR exists and is unique if one or more years of net investment (negative cash flow) are followed by years of net revenues.

In general, the IRR can be calculated by solving a polynomial. Sturm's Theorem can be used to determine if that polynomial has a unique real solution. Importantly, the IRR equation cannot be solved analytically (i.e., in its general form) but only via iterations.

A critical shortcoming of the IRR method is that it is commonly misunderstood to convey the actual annual profitability of an investment. However, this is not the case because intermediate cash flows are almost never reinvested at the project's IRR; and, therefore, the actual rate of return (akin to the one that would have been yielded by stocks or bank deposits) is almost certainly going to be lower. Accordingly, a new measure called Modified Internal Rate of Return (MIRR) is used.

In spite of a strong academic preference for NPV, surveys indicate that executives prefer IRR over NPV. Apparently, managers find it intuitively more appealing to evaluate investments in terms of percentage rates of return than Rs of NPV.

Discounted cash flow (DCF)

A **discounted cash flow** or DCF is the value of a cash flow adjusted for the time value of money and is a form of present value analysis. The nominal values of two cash flows (positive or negative) in different time periods cannot be directly compared because of the preference of most people for consumption sooner rather than later. The presumption behind this principle’s that a dollar in your hand today is worth more than a dollar you may receive at some point in the future: or, more colloquially, “a bird in the hand is worth two in the bush”. Similarly, a dollar you have to spend three years from now costs you less than a dollar you have to spend today. This is due to opportunity cost and risk over time.

Opportunity cost is significant because any financial decision must be measured against a default low-risk investment alternative (usually the rate of a Treasury bond of similar yield period) or the inflation rate. *Risk* becomes a significant factor when the financial decision being considered involves some statistically significant probability of loss. Calculation of risk factors beyond opportunity cost can often be very complex and imprecise, requiring the use of actuarial analysis methods and in-depth market analysis. When risk is included in DCF analysis, it is generally done so according to the premise that investments should compensate the investor in proportion to the magnitude of the risk taken by investing. A large risk should have a high probability of producing a large return or it is not justifiable.

By combining assessments of both opportunity cost and risk, a discount rate (or “hurdle rate” if the DCF analysis is being used to set future business performance expectations) is calculated for the analysis of the present value of anticipated future cash flows.
Discounted cash flow analysis is widely used in investment finance, real estate development, and corporate financial management.

Formula

The discounted cash flow formula is derived from the future value formula for calculating the time value of money and compounding returns.

$$FV = PV.(1+i)^n$$

The simplified version of the Discounted cash flow equation (for one cash flow in one future period) is expressed as:

$$DPV = \left(\frac{1}{(1+d)^n}\right) * FV$$

Where

DPV is the discounted present value of the future cash flow (FV), or *FV* adjusted for the opportunity cost of future receipts and risk of loss;

FV is the nominal value of a cash flow amount in a future period;
d is the discount rate, which is the opportunity cost plus risk factor (or the time value of money: "i" in the future-value equation);

n is the number of discounting periods used (the period in which the future cash flow occurs). i.e., if the receipts occur at the end of year 1, n will be equal to 1; at the end of year 2, 2—likewise, if the cash flow happens instantly, n becomes 0, rendering the expression an identity (DPV=FV).

Where multiple cash flows in multiple time periods are discounted, it is necessary to sum them as follows:

$$DPV = \sum_{t=0}^{N} \frac{FV_t}{(1+d)^t}$$

For each future cash flow (FV) at any time period (t) for all time periods.

Example DCF

To show how discounted cash flow analysis is performed, consider the following simplified example.

Ram Dass buys an Information system for Rs. 100,000. Three years later, he expects to be able to sell his product with addional Rs. 150,000 because of improved marketability of his product by using the Information system.

Simple subtraction suggests that the value of his profit on such a transaction would be Rs. 150,000 – Rs. 100,000 = Rs. 50,000, or 50%. If that Rs. 50,000 were amortized over the three years, his implied annual return (known as the internal rate of return) would be about 13.6%. Looking at those figures, he might be justified in thinking that the purchase looked like a good idea.

However, since three years have passed between the purchase and the sale, any cash flow from the sale must be discounted accordingly.

At the time Ram Dass buys the Information system, the 3-year Treasury Bill rate is 5%. Treasury Bills are generally considered to be inherently less risky than real estate, since the Government guarantees the value of the Bill and there is a liquid market for the purchase and sale of T-Bills.

So, calculating exclusively for opportunity cost, we get a discount rate of 5% per year. Using the DCF formula above, we see that the net present value of Rs. 150,000 received in three years is actually Rs. 129,146 (rounded off). Those future rupees aren't worth the same as the rupees we have now.

Using simple subtraction again, the present-value profit on the sale would then be Rs. 29,146 or a little more than 29%. Amortized over the three years, that implies a discounted annual return of 8.6% (still very respectable, but only 63% of the profit he previously thought he would have). Note that the original internal rate of return (13.6%) minus the discount rate (5%) equals the discounted internal rate of return (8.6%). The discount rate directly modifies the annual rate of return.

But what about risk?

The Information system Ram Dass is buying is a "good system", but market values have been rising quite a lot lately and the market analysts in the media are talking about a slow-down and higher interest rates. There is a probability that Ram Dass might not be able to get the full Rs. 150,000 he is expecting in three years due to a slowing of price appreciation, or that loss of liquidity in the product market might make it very hard for him to sell at all.

For the sake of the example, let's then estimate his risk factor is about 5% (we could perform a more precise probabilistic analysis of the risk, but that is beyond the scope of the study material here). Therefore, this analysis should now include both opportunity cost (5%) and risk (5%), for a total discount rate of 10% per year.

Going back to the DCF formula, Rs. 150,000 received three years from now and discounted at a rate of 10% is only worth Rs. 111,261 (rounded off) in present-day rupees. The present-value profit on the sale is now down to Rs. 11,261 discounted rupees from Rs. 50,000 nominal Rupees. The implied annual rate of return on that discounted profit is now 3.6% per year.

That return rate may seem low, but it is still positive after all of our discounting, suggesting that the investment decision is probably a good one: it produces enough profit to compensate for opportunity cost and risk with a little extra left over. When investors and managers perform DCF analysis, the important thing is that the net present value of the decision after discounting all future cash flows should at least be positive (more than zero). If it is negative, that means that the investment decision would actually *lose* money even it appears to generate a nominal profit. For instance, if the expected addional sale price of Ram Dass's product in the example above was not Rs. 150,000 in three years, but *Rs. 130,000* in three years or Rs. 150,000 in *five* years, then buying the Information system would actually cause Ram Dass to *lose* money in present-value terms (about Rs. 6,000 in the first case, and about Rs. 9,000 in the second). Similarly, if the Information system was not yielding the desirable results and the Reserve Bank was about to raise interest rates by five percentage points, then the risk factor would be a lot higher than 5%: it might not be possible for him to make a profit in discounted terms even if he could sell the product for addional *Rs.200,000* in three years.

In this example, only one future cash flow was considered. For a decision, which generates multiple cash flows in multiple time periods, DCF analysis must be performed on each cash flow in each period and summed into a single net present value.

Pay Back Period

Pay Back Period is the time required to pay back the initial investment of the project. The payback period is computed as

$$\text{Number of years to pay back} = \frac{\text{Original Investment}}{\text{Actual Net Cash flow}}$$

The payback period method is a popular method because of its simplicity and power as an initial screening method. It is especially suited for high risk projects in the which useful life of the project is difficult to assess. If a project pays for itself in three years, then it hardly matters how useful the system remains after three years.

The weakness of this method lies in its not considering the time value of money, the amount of cash flows after the payback period.

Limitations of Traditional Financial Evaluation Procedures

Assessment of benefits in case of the Information Systems implementation are more difficult and variation in actual and expected benefits may be larger because of the following factors:

- IS implementation is closely related to organisational culture and therefore may vary from organisation to organisation; in other words the assessment has to be organisation specific.
- IS implementation in bulk of the cases presents a first time case situation; therefore, previous data is not available.
- IS implementation in many cases undergoes change during implementation so initial estimates may be quite different.
- Valuation of intangible factors may be subjective or may not be possible at all.
- Time over-runs and cost over-runs may be there.
- It does take into account risk factors.
- It does not take into account the strategic considerations.

Other Methods of Evaluation

The conventional financial budgeting systems do not take into consideration the strategic considerations, while the other methods namely *Real options pricing models*, *scoring models* and *portfolio analysis* involve strategic considerations. Real options pricing model and scoring model are discussed in detail here, while portfolio analysis will just be briefly touched upon here as it is being discussed in detail in unit 5.

Real Option Pricing Model

The Real option pricing model makes it possible to arrive at the strategic decision whether a project needs to be taken up immediately or later? When will it be more beneficial? This will be clear from the example showing how the flexibility of a project is important in evaluating the project's benefits. You want to buy an Information System module for your works to improve productivity. You find that two types of systems are available, one (costing Rs. one million) covering production planning for the present models of the cars being manufactured and the other one (costing Rs. 1.2 million) covering besides present models, the additional models that the company is planning to cover. The additional models are expected only after next two years. All other factors in both the modules are same. You end up comparing two information systems that are identical, with the exception that one takes care of new models also. Not surprisingly, the system covering additional models is more expensive. Why would you even consider buying the second system? Because of the added flexibility that the second system provides for future models also. Is the flexibility of the second system worth Rs. 0.2 million is going to depend on variables such as the time when new models are started, what will be sale volume of those models, and cost and profit margin? Complicating the process is the fact that the value for the variables will change over time. In the end, it comes down to a subjective judgment on your part whether the additional Rs. 0.2 million cost for the new model is worth it.

If you get together with a group of managers to discuss which of the two systems to buy, without any doubt all will agree that the second system is more flexible. However, it is certain that there won't be complete agreement on how valuable the flexibility difference is between the two systems. On the other hand, if you develop a real options model of the decision you might find that the added flexibility of the second system is worth Rs. 0.27 million. Since the additional cost would be less than that (i.e., Rs. 0.2 million), buying the second system would be worthwhile.

Types of Real Options

Real options have been broken down into six categories based upon the type of flexibility provided. The six categories are: the option to defer; the option for staged investments; the option to change scale; the option to abandon; the option to switch; and the option to grow.

The option to defer occurs when you can put off a decision until some date in the future. This allows management to determine if resources should be spent on a project at that future date. For example, your long lost uncle leaves you a gold mine instead of cash. A trip to the mine shows you that there is gold in the mine; however, the cost of removing the gold is more than the gold is worth. If you keep the mine, you have to pay a small property tax on the land every year. Paying the small tax allows you to defer the decision on whether to extract the gold. Right now the gold is essentially worthless, but the price of gold might suddenly sky rocket making the cost of extracting the gold worthwhile. Therefore paying the small tax allows you to delay a decision on whether to extract the gold if conditions change.

The option for staged investments occurs when a project investment happens in a series of outlays that allows the project to be abandoned mid-stream if conditions become unfavourable. The development of a project can be considered to be a series of options. Each stage in development can be considered an option on the value of future stages. You decide you want to convert the gold mine you inherited in the previous example to a tourist attraction. You draw up the plans for a theme park, however, you build only one concession stand at first. If people really enjoy your attraction, you can expand the concession stand and add a ride. On the other hand, if there is suddenly an overabundance of gold mine attractions, you don't have to expand your concession stand. Thus building in stages allows you to abandon or change the project if future conditions deteriorate.

The option to change scale can result in the project being expanded, contracted, or shut down and restart. Depending on market conditions that prevail at a particular time, the rate of resource expenditure can be adjusted to meet the new conditions. For example, you have decided to replace your personal computer. You go to your local computer superstore and see what is available. Presently you are using your computer only for word processing and spreadsheets. You don't really need a high end color monitor, 32 megabytes of memory, and a 2 gigabyte hard drive. So why don't you buy a stripped down system that is adequate for your existing needs? Because, you don't know, what you will need to do tomorrow with your machine. You might suddenly have to develop a World Wide Web site for your company or put together presentations, or suddenly your kids decide they "need" to have the latest games. Even if your needs don't change, the existing software you use may be revised and you no longer have the capability to run the new versions on your machine. Thus, you go with the machine that is more powerful than your existing needs so that if your needs expand, you do not have to start over and purchase a new machine.

The option to abandon allows the company to abandon a project if the market conditions drop dramatically. The company can then sell off any assets available to offset the loss or switch those assets to other projects. For example, you buy a new IBM PC to be able to work at home. Suddenly, your company decides to switch from PC to Macintosh and you need to get a new computer. Fortunately, your teenage daughter is going away to college in a couple of months and will be required to buy a PC. So you now turn over your PC to your daughter and no longer have to buy her one. Therefore, even though the PC cost Rs. 30,000, you didn't lose all the value when you abandoned it. Rather you shifted the resource to another location where it was still valuable.

The option to switch allows an organisation to change either the input mix or output mix of a facility. If environmental conditions change, this option provides the flexibility to alter either the process (i.e., input mix) or product (i.e., output mix).

The option to grow is used when an initial investment is required for further development. The project can be considered a link in a chain of related projects. Each project in the link is required for future growth. An organisation may invest in research and development even though it typically has a negative value when looked at in isolation. It invests because of the future growth value of the results of that research and development. For example, you are convinced that your gold mine attraction will be a winning idea but presently the only way to reach the gold mine is by a one mile burro ride. You decide to build a road to connect your gold mine with the highway. Looking at the costs and benefits of the road in isolation, the costs outweigh the benefits and it does not make sense to put in the road. However, you realize that without the road, the rest of the project is not feasible. Therefore, you decide to build the road even with its negative cost analysis because it is required as part of the first stage in developing your gold mine attraction.

Many projects do not have only a single real option that is applicable to them. Depending on the type of project, more than one real option may need to be considered when computing the value of the real options. For example, we used the same gold mine example in three of the cases above. However, it is important to realise that these real options can interact in various ways. The value of the interacting multiple options may not be equivalent to the value of the individual real options added together.

Scoring Models

For arriving at a decision on alternative systems *scoring model* is a quick and suitable method. This method gives alternative systems a single score based on the extent to which they meet selected objectives.

This method is illustrated in *Table 4* In this example a firm has to choose one of three alternatives office systems (a) a UNIX based client / server system using an Oracle data base, (b) a Window based client / server system using Windows XP, Windows.Net server and Lotus Notes, and (c) an IBM AS/400 client server system with proprietary software. As shown in the *Table 2* column 1 indicates the criteria that decision makers agree to apply on the systems. Column 2 lists the weight that decision makers attach to the decision criteria. Now the decision makers' move on to the next step of ranking the systems for each criterion based on the degree of user needs each system meets for that criterion. The system getting the highest score is considered / evaluated the best and selected. In this example Windows XP is the preferred system. The crucial aspect of this method lies in the fact that the decision makers have to agree on the criteria of selection, their weights and the final score for each criteria for each option. Thus the system chosen is based on consensus decision.

Table 2: Scoring Model – Evaluation / Selection of Three Office Systems

Criteria	Weight	UNIX		Windows XP		AS/ 400	
% of user needs met	0.40	3	1.2	4	1.6	2	0.8
Cost of initial purchase	0.20	3	0.6	4	0.8	1	0.2
Financing	0.10	3	o.3	4	0.4	1	0.1
Ease of maintenance	0.10	3	0.3	4	0.4	2	0.2
Chances of success	0.20	4	0.8	4	0.8	3	0.6
Final Score (Scale High = 5, Low = 1)	1.00		3.2		4.0		1.9

The success of this model lies in consensus, which may take considerable deliberation.

Portfolio Analysis

This method enables selection from alternative systems based on strategic and risk considerations. This will be discussed in detail in unit 5.

4.5 TOTAL COST OF OWNERSHIP

The *total cost of ownership* (TCO) of an information system is defined as the total cost of acquiring, implementing, and *keeping* that system running. It's an accounting methodology that today is proving to be crucial in making sound IT decisions.

Many IT professionals conveniently factor in only the costs of purchasing hardware and software when doing TCO analysis. This isn't surprising; when pressed for time, they only take into account what's easy to find out. In the relatively easy-to-manage world of mainframes and big centralized information systems, hardware and software accounted for much of the cost factors. In the current era of e-business, client /server, and peer-to-peer systems, however, the costs of *managing and maintaining* information systems is often much higher and cannot be ignored.

Cost factors, which should go into the computation of the TCO of any system, can be grouped into *direct* and *indirect* costs.

Direct costs pertain to the acquisition expenses or the cost of buying the system, and cover all of the following activities:

- **Researching** possible products to buy, which is essentially a labour cost but may also include materials cost, such as purchase of third-party research reports or consultant fees.

- **Designing** the system and all the necessary components to ensure that they work well together. Naturally, this cost component will be higher if a move to a totally different system platform is being considered.

- **Sourcing** the products, this means getting the best possible deal from all possible vendors through solicited bids or market research. It's often sufficient to get a quotation from three vendors (with the cheapest one not necessarily being the best choice). With the Internet, it's easy to get price quotations even from sources outside the country, to get a good spectrum of pricing options.

- **Purchasing** the product(s), which includes the selling price of the hardware, software, and other materials as negotiated with the chosen suppliers. Include all applicable taxes that might be incurred. Don't forget to consider the costs of the systems at the end-user side; some system choices might entail a change or upgrade at that end.

- **Delivering** the system, which includes any shipping or transportation charges that might be incurred to get the product into its final installation location.

- **Installing** the system. Bear in mind that installation also incurs costs in utilities and other environmental — not just labour costs. If the installation of the system will result in downtime for an existing system, relevant outage costs must be included. Any lost end-user productivity hours during this activity should also be factored in.

- **Developing or customizing** the application(s) to be used.

- **Training** users on the new system.

- **Deploying** the system, including transitioning existing business processes and complete integration with other existing computing resources and applications. Include here the costs to promote the use of the new system among end users.

- **Indirect costs** address the issues of maintaining availability of the system to end users and keeping the system running, which includes the following:

  - ***Operations management***, including every aspect of maintaining normal operations, such as activation and shutdown, job control, output management, and backup and recovery.

  - ***Systems management***, such as problem management, change management, performance management, and other areas.

  - ***Maintenance of hardware and software components***, including preventive maintenance, corrective maintenance, and general housekeeping.

  - ***Ongoing license fees***, especially for software and applications.

  - ***Upgrade costs*** over time that may be required.

  - ***User support***, including ongoing training, help desk facilities, and problem-resolution costs. Remember to include any costs to get assistance from third-parties, such as maintenance agreements and other service subscriptions.

  - ***Environmental factors*** affecting the system's external requirements for proper operation, such as air conditioning, power supply, housing, and floor space.

  - ***Other factors*** that don't fall into any of the above categories, depending on the type of system deployed and the prevailing circumstances.

All these cost factors seem fairly obvious, but quantifying each cost is difficult or impractical in today's world, because few organisations have an accounting practice that's mature enough to identify and break down all these types of expenses in sufficient detail. For example, very few organisations record all employee activities by task and hours used—information you would need to answer questions like these: *What support costs did you incur last month? How much time did each user spend in solving computer-related problems? How much work was lost due to downtime on desktop PCs?*

Additionally, companies rarely have accurate inventory and asset information regarding their computing systems, especially in large, multi-location computing environments where PC, server, and local network purchasing decisions are often handled at the department level.

So, what's the value of knowing a system's TCO? Obviously, our objective is not to calculate exact figures. Rather, you need to understand what these costs *could reasonably be* in your organisation. You must plan for these costs, even if you can only roughly estimate them. A fair amount of intelligent "guesstimation" is much better than blindly deciding on an IT solution on the basis of sticker price alone. In addition, TCO analysis provides a good basis of comparison between alternative system-deployment strategies, between platform choices, and between competing products.

Industry TCO Estimates

When IT and user labour costs are factored in, industry consultants have estimated the TCO of typical office PC systems from as low as Rs. 120,000 to as high as Rs. 400,000 per unit, *per year*. Note that typical PC hardware and software prices range from a low of Rs. 30,000 to a high of Rs. 80,000 for desktop units.

An example of how TCO can help in making a decision on system migration is a recent analysis by the Gartner Group that estimates the migration costs per PC system going from a Windows 98 to a Windows 2000 platform to be anywhere from Rs. 80,000 to Rs. 120,000. The same sort of analysis by Giga Group — but quantifying the labour savings gained — puts the cost of migration at Rs. 38,000 per system. In Giga Group's approach, they tried to quantify the gain in user productivity hours from the use of the much more stable Windows 2000 operating system.

Although all analyst's TCO estimates vary considerably, they all point to the fact that –

- TCO results will be very different for every organisation, given their varied computing environment, user experience level and IT expertise.
- PC systems have much higher indirect costs than direct costs.
- TCO analysis is never going to be an exact science, due to the many assumptions and unknowns that have to be taken into account.
- As you provide more functionality and capability to end users, TCO rises. As you install more software or provide more complex hardware at the hands of end users, you pay increasingly more for support and maintenance.

TCO provides a good model for evaluating computing costs — direct and indirect, visible and invisible, budgeted and unbudgeted. Of course, TCO cannot be your sole determining factor for choosing a computing system. What we are driving at here is that you should be aware of these costs and plan for them.

At the same time however, you must always balance the costs of providing a system versus the benefits it brings to the business and the end users. Many decisions you make will not be due to cost-avoidance but rather on the basis of business advantage. A case in point is having Internet connectivity. On the one hand, providing such a facility for the enterprise means additional investments in firewalls and other security products, as well as a dramatic rise in potential damage from hackers, viruses, and other malicious activities. But on the other hand, what business can adequately compete or even survive without the access to information, worldwide reach, and accessibility to customers that the Internet provides?

What TCO Studies Reveal

TCO studies of PCs, PDAs, and other end-user – oriented computing platforms have identified several key, hidden, and oftentimes un-budgeted costs due to the following phenomena:

Fiddle factor: Users often spend excessive time changing minor look-and-feel items on their systems — time that could instead be spent performing productive work. Examples include changing how the Windows desktop looks (color, size, icons, screensavers), installing applets or utilities (pop-up messages, animated cursors, desktop accessories), and trying out different fonts or lettering styles in documents. These activities distract users from the more important task of ensuring quality content in their work.

Peer support and self-help phenomena: When end users encounter problems, they rarely seek IT help. They either try to solve the problem on their own or ask colleagues to assist, taking themselves and their co-workers away from primary job responsibilities. Not only that; as users try to gain as much computer expertise as possible, they often neglect the skills they need in their line of work. Most of their computer skill is learned informally, by time-consuming experimentation that often causes even more complex problems.

User-introduced problems: Often, users themselves cause unnecessary downtime and lost productivity through activities such as these:

- Deleting critical system files by accident or experimentation.
- Changing parameters in the Windows system registry, control panel, and other configuration files.
- Installing new software that causes system instabilities, security exposures, or counterproductive activities (for example, utilities or games).

The Underlying Reason for High TCO

Where a company's systems have especially high TCO, its systems were most likely deployed with only the following objectives in mind:

- **Functionality:** The capability of a computer to perform the tasks and run the applications required by the user.
- **Performance:** The capability of a computer to respond to user input as quickly as possible (often referred to as *system response time*).
- **Capacity:** The capability to handle growth in concurrent users, amount of data processed, number of transactions completed, or other metrics.

After the systems are deployed, issues not directly related to these criteria crop up-issues that prove every bit as important to users over the long term. These *post-deployment requirements* include

- **Availability:** The system or application is there when the user needs it.
- **Ease of use:** No complicated procedures to learn or remember.
- **Assistance:** If the user has a problem, help is easily accessible.
- **Security:** The user's work is protected from loss or unauthorized access.

In all cases where the TCO of a system is unnecessarily high, it's because the system or application was designed without taking into consideration the post-deployment user requirements above, particularly availability, security, and assistance.

Availability as the Most Significant Contributor to TCO

Experience with information systems has shown us that the user requirement responsible for the greatest hidden costs is *availability*. This user requirement takes precedence over all others: What good is a system if it's unavailable? Availability also requires ongoing management and maintenance throughout the entire life of every system.

A system is considered available when users can work with it without experiencing outages. Availability is measured from the user's point of view. It deals not only with the prevention of real system outages, but with user-perceived outages as well. These perceived outages are anything that prevents the user from working with the system productively, such as prolonged response times, lack of assistance, or lack of available workstations. As long as the user doesn't perceive or feel the outage, the system is considered "available."

A user will consider a system unavailable if one of these conditions occurs:

- **The system is not accessible:** If the user can't access the resources s/he needs to run an application, the system is considered unavailable. The system is equally unavailable if all workstations or software licenses are in use, or if the network connection to necessary data is down, or if the system has a virus infection.

- **The system is running too slowly:** The system may be operational, but if the response time is long the user will give up waiting and consider the system as unavailable.

- **The system is intermittently having problems:** The user will choose not to use a system if s/he suspects that work may be lost due to intermittent system failures.

TCO Summary

In today's widely distributed IT computing environment, we must understand TCO in order to effectively evaluate all of our deployment alternatives. All studies on TCO have shown that the TCO of interconnected servers, workstations, and intelligent access devices is higher compared to the centralised mainframe and dumb terminals of yesteryear, and the key reason is the lack of attention to post-deployment system requirements, especially the availability requirement.

If a system is designed, deployed, and managed without special attention to organisation, people, process, and technology issues, the total cost of ownership will definitely spiral out of control.

4.6 CULTURE FOR INFORMATION SYSTEMS

Culture is a multi-faceted entity that is hard, if not impossible, to define. For our purposes, we can start with an understanding of culture as the totality of shared meanings and interpretations of a given group. This repository of shared understandings and interpretations of the world is represented by symbols whose meanings and interpretations, members of the same culture share. The exchange of meanings and the agreement on appropriate interpretations of symbols is linked closely to communication. Without communication, no culture could exist, which, in turn, underlines the social nature of culture.

This is a rather wide understanding of culture that requires further specification. It is useful, however, because it allows an understanding of culture as a multiple phenomenon with areas of overlap and frequent change. For example, it facilitates cultures of different reach, such as organisational culture and national culture. Most organisations will have some particularities that are meaningful to their members, and that outsiders cannot access easily. Thus, they fulfil the definition of culture, and arguably, they require a culture in order to facilitate their long-term survival. A similar description can be found for national cultures; namely, that they are the collection of things, ideas, and techniques, including institutions, that a society needs, to persist. It should be clear that such a definition of culture would not allow easy delimitations and distinctions. Most individuals will be members of a variety of cultures (i.e., company, sports club, ethnic group, nation, region). These memberships may be mutually reinforcing, but they also may be contradictory.

An important aspect of culture is that it has a normative function. This means that cultures contain an idea of how things should be and how its members are expected to behave. This means that they are inherently utopian and imply a good state of the world. There are different ways in which the normative character of cultures is transmitted. One of these ways is what we usually call ethics or morality. This refers to the norms that are accepted in a given culture and the justification of such norms. It also can be translated in terms of values that are implicit in all cultures. Therefore, one can say that culture is a "value concept". A related and very important aspect is that of religion. Religions, too, contain shared symbols and meanings and provide their members with normative guidance. Religions, therefore, can be seen in this context as a subset of cultures but as an important one, which strongly affects different cultures.

All of this should render it clear that cultures are linked deeply to questions of identity. On an individual level, identity as the answer to the question, "Who am I?" is answered by a collection of narratives. These narratives draw on the cultures of which the individual is a member. Clashes of cultures, therefore, can lead to contradictory influences on identity and to cognitive dissonance, which can lead to pathological developments.

Culture, thus one can claim, is a universal ingredient of human existence. Humans are symbol-using beings who live in a largely self-constructed environment, require continued cooperation to survive, and cannot live without culture. Thus, culture is a necessary ingredient of all communities and societies. At the same time, cultures also can be problematic. The fact that they determine their members' views of reality and morality means that they are close to and easily used by ideology. A culture can justify and help appear normal the things and actions that appear repulsive and immoral to other cultures. This leads us to the difficult question whether there are universal aspects of all cultures that would allow cross-cultural dialogue aimed at addressing such contradictions.

Traditionally the information systems (IS) designers have followed simple concepts of organisational functioning based overwhelmingly on ideas of management control. Data from operational activity is processed for use as information for management to use in planning, decision-making and supervision. While this viewpoint fits some organisations it is not appropriate to all. Organisational culture and national culture, may be readily overlooked by the IS designer. We will discuss the major dimensions of the impact of culture on an organisation's information systems.

Culture and Information System

Inside working organisations, as in all areas of human activity, the behavior of people is affected by the values and attitudes that they hold. The collective patterns of behaviour are important parts of the culture of the work-group or nation, which form a backdrop against which values and attitudes are in turn developed. This cycle is shown in *Figure 4*.

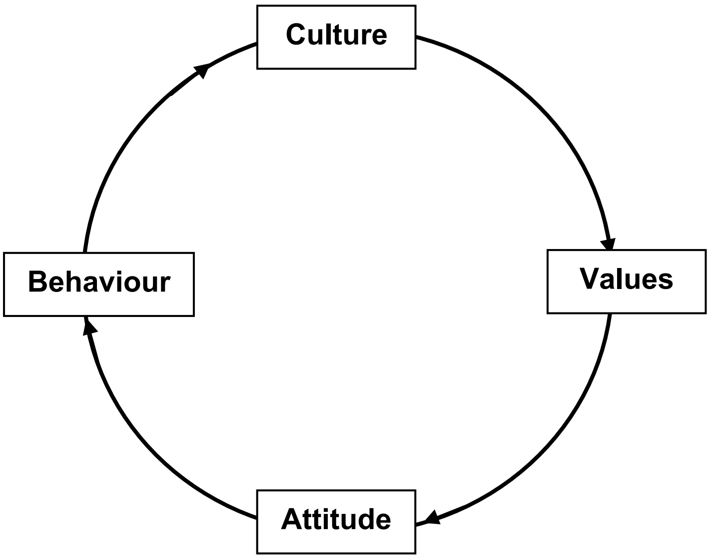

Figure 4: The Influence of culture on behaviours

Data only becomes information when a person interprets it, and this interpretation of necessity takes place against the backdrop of the individual's culture. In decision-making, information is a prerequisite and the decision-making process is deeply affected by culture. Thus the meaning of information and effectiveness of an information system can vary substantially in different cultures. National cultures have long been associated with differences in the organising and operating of businesses and, more recently, cultures specific to organisations have been given due importance.

It is today an established realisation that the nature and role of information is central to the organisations, and, just as emphatically, the culture has a critical impact on the selection, analysis and design of information systems. The first step for the IS designer, before any systems investigations are commenced, has to be a study of the *organisation's culture*, and in the case of transnational and multinational systems, the *national cultures* involved. These will give warnings of modes of information handling, supervision and control that will be intimately concerned in any information system to be introduced.

National culture

The importance of national values as they impact upon corporate culture has been well established. A clear link from Japanese national culture to the corporate cultures of major organisations and then to the outstanding success of Japanese business has been an established fact. The interest of some of the top leaders of Indian industry was the possibility of transferring or creating Japanese-like corporate values (and hence culture) in Indian industry in order to generate similar successes. It was found that some Indian organisations already had cultures much like Japanese organisations and, it was felt, this was significant in their success.

Dimensions of power distance and uncertainty avoidance may be of great significance to the IS designer, especially if the values are extreme, that is, very high or very low. Such extreme values can lead to systematic rejection of information that conforms to recognisable types. Other extreme values may lead to over-reliance on information to the detriment of the organisation. By being aware of the environment the IS designer may be able to foresee some of the dangers. These are most acute for a designer who is not a national of the country where development is taking place. The dangers can be summarised briefly as:

If uncertainty avoidance is strong then an MIS is needed to try to reduce the uncertainty even if that is impossible; systems may become rituals, If uncertainty avoidance is weak, fatalism leads to skepticism about MIS and resistance from users, If power distance is large then the boss disagrees with the MIS and the boss is right, If power distance is small, authoritative approaches will be risky.

Organisational / Corporate Culture

One common thread that greatly affects many of the organisational aspects that enhance performance and increase productivity is the widely shared and strongly held values that underlie and define an organisation's culture. Organisational (or corporate) culture can be defined as "the pattern of shared values and beliefs that help individuals understand organisational functioning and thus provide them with the norms for behaviour in the organisation. Culture can also provide a key to understand issues such as "why things happen the way they do," and in understanding organisational climate as "what happens around here." Cultures can be determined by the values, assumptions and interpretations of organisation members.

These factors can be organized by a common set of dimensions on both psychological and organisational levels to derive a model of culture types to describe organisations. Corporate culture is an important predictor of organisational capabilities and outcomes such as customer orientation and new product development. For many years, scholars in organisational behaviour have also attempted to demonstrate the link between an organisation's culture and its performance. It has been argued that the success of an organisation's strategy depends, to a significant extent, on the culture of the organisation. In considering culture in the light of a strategic management paradigm, it has been argued that, for an organisation's culture to provide sustained competitive advantages, it must add value. It must be rare or unique and be difficult to imitate by competitors.

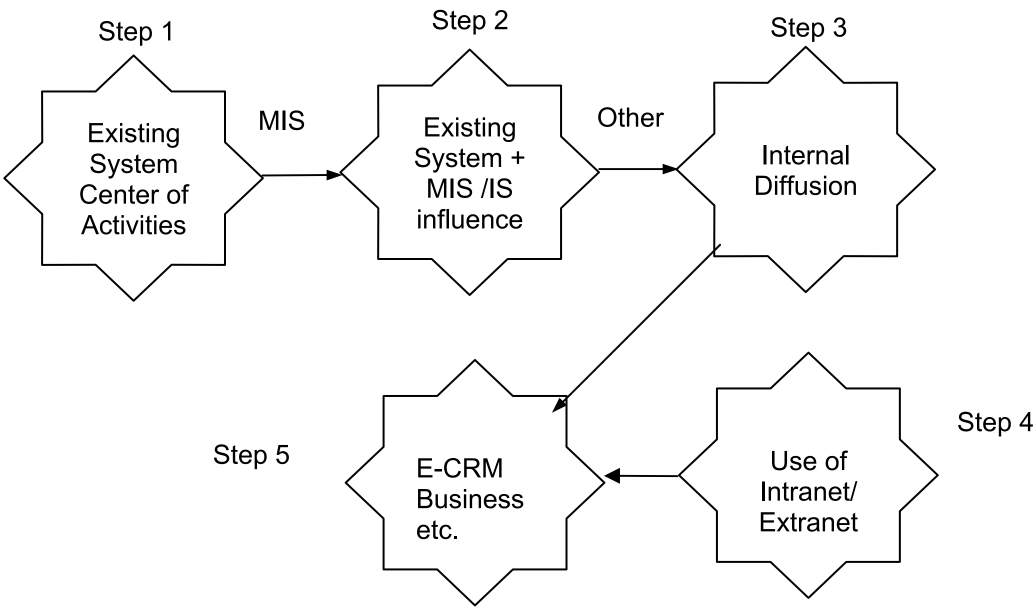

Figure 5: Information flow and adoption

Information System Adoption

Figure 5 provides an overall illustration of how an organisation adopts an information system and the numerous factors that influence the adoption process. A whole range of economic, social, political and technological factors that influence decision-making and performance surrounds an organisation. Other factors in the external environment constitute the organisation's customers, distributors, suppliers and the competition. These forces constitute the external macro-environment as well as microenvironment forces. They need to be scanned to determine opportunities and threats for the business.

The internal environment of the organisation could be made up of tangible factors such as the physical plant and equipment and the intangible factors such as the skills of the employees within the organisation. To be able to survive in the highly competitive business world, a business must identify its strengths and weaknesses, sharpen its core competencies and leverage them for competitive advantage. The important role IS plays in business is well known.

Thus, the current information technology system of an organisation constitutes the center of IS influences (step 1). Such influences could be made up of old legacy systems, integrated systems, semi-integrated systems or stand-alone Information Systems. Depending on the organisational size, the market nature and type of products being produced and the perceived benefits of IS, certain portals are able to penetrate the organisation to varying degrees to influence adoption (step 2). Penetration and adoption are typically facilitated by top management, cultural orientation of the organisation, management information systems or the information technology itself as alluded to in earlier sections of this unit. Once these factors have successfully penetrated the organisation to influence the adoption of IS, internal diffusion occurs (step 3). The diffusion is considerably affected by the cultural orientation of the organisation to create strong or weak relationships of the factors that lead to the penetration, adoption and diffusion. Based on the corporate culture with respect to IS adoption, the organisation may utilise IS for internal consumption (Intranet), external consumption (Extranet), a network of computer networks for global application (Internet) database management, enterprise resource planning and many other IS applications (step 4). In the highest order application of IS, e-Business takes place with interorganisational connectivity (step 5). This can be done with its exchange partners, such as its customers, which include order taking, order process, order payment, dispatch, order tracking and after-sales customer support. Others include suppliers for procurement processes and overall supply chain management.

Corporate Culture Impact on Information System Adoption

The established factors of corporate culture having deep impact on the Information system are shown in *Figure 6*. These factors have been discussed one by one.

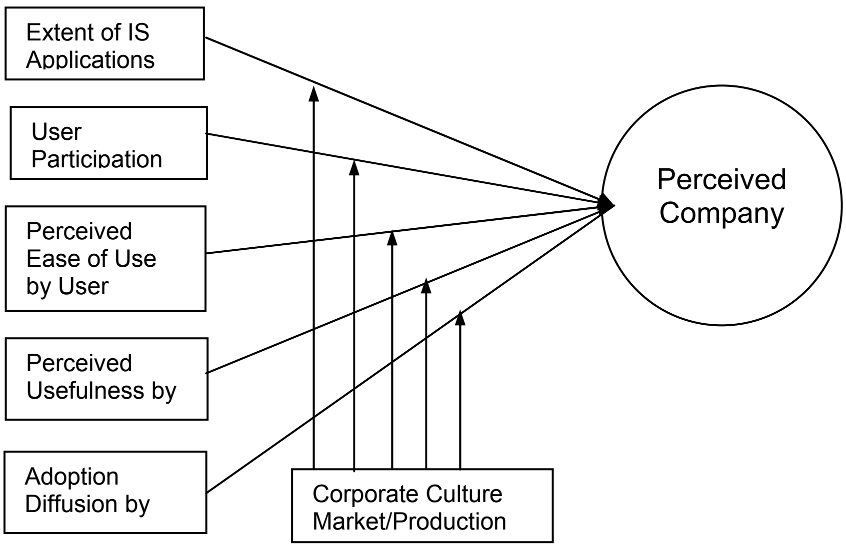

Figure 6: Impact of corporate culture on information system

Extent of Application

The "extent of application" factor describes the extent to which an organisation applies IT to making, implementing and evaluating organisational decisions. Its benefits are commonly based on enhanced decision-making or improved business performance. The use of information in decision-making involves integrating information sources and selecting from among alternative strategies, whereas information use in decision implementation concerns how decisions should be carried out. Information use in evaluation, on the other hand, refers to the determination of positive and negative performance outcomes and the reasons for the outcomes.

The development of IT comes with a significant risk of whether the end users will actually use it or not. To ensure continued use, external variables (such as technical features and organisational environment), internal psychological variables (such as past education and attitude to system use) and past usage (prior experience) must be considered. Users of IT must realize the full potential of the technology, they must be willing to use the technology and become effective users. Unfortunately, many IT applications are misused, underutilised or abandoned.

User Participation

The relationship between user participation and information system (IS) has been significant because of its potential impact on the success of systems. User participation could be considered as "taking part" in some activity. Such participation may be direct or indirect, formal or informal, performed alone or in a group, covering varying scopes of activities during systems development and implementation. It may be mentioned that assessing a wide variety of specific behaviours, activities and assignments is more accurate, reliable and valid than measures assessing general opinions during user participation evaluation.

Systems development, as a result of being marked by cost overruns, late deliveries, poor reliability and user dissatisfaction, in many cases, does not achieve the expected strategic benefits. It has been suggested that the participation of users in the design and implementation of IT promotes greater user acceptance, IT usage, system quality, organisational impact and increased user satisfaction, which could lead to increased IT implementation success. Cultures that are high in trust and mutual supportiveness foster higher levels of communication, shared identity and commitment. which enhances user participation. Greater the user participation in the project, the greater will be the establishment of trust in the success of the project because the users will be able to identify loopholes in the project before final implementation and will also feel committed to make it work. This also generates confidence in the users that the IT system is reliable and encourages users to take risks.

User participation facilitates organisational learning by bringing together all dispersed knowledge from the various units within the organisation to one spot where employees can access information, learn from one another and benefit from new knowledge developed by other units. This provides opportunities for mutual learning and inter-unit cooperation that stimulate the creation of new knowledge and, at the same time, contribute to organisational units' abilities to innovate.

Perceived Ease of Use

Perceived ease of use has been an established factor influencing user acceptance and usage behavior of information technologies. It describes the individual's perception of how easy the innovation is to learn and use. This includes support, complexity and change. It has been observed that six variables contribute significantly to how users perceive the ease of use of specific IT systems over time in an actual corporate setting. These variables include computer self-efficacy, facilitating conditions, intrinsic motivation / computer playfulness, emotion / level of computer anxiety, objective usability and perceived enjoyment. Self-efficacy has a strong direct effect on perceived ease of use, but only an indirect effect on perceived usefulness through perceived ease of use. Another factor, past usage (prior experience), also apparently influences the ease of use of the system, and this is a key factor in determining future usage.

Perceived Usefulness

Perceived usefulness describes the perceptions of the individual regarding the innovation and has been found to influence an individual's adoption behaviors. Perceived usefulness can also be defined as "the degree to which a person believes that using a particular system would enhance his or her performance." It is an example of extrinsic motivation, which is found to play a greater role in an individual's behavior. The most important consumer attitudes underlying perceived usefulness of and willingness to use IT are expectations of accuracy, security, network speed, user-friendliness, user participation and convenience. User satisfaction, in turn, is influenced also by the user's confirmation of expectation from prior IT use and perceived usefulness, and this is influenced by the user's confirmation level.

Adoption Diffusion

The process of information technology adoption and use is critical to deriving the benefits of information technology. Understanding how users form perceptions of an IT innovation would help designers, implementers and users in their evaluation, selection, implementation and on-going use of IT. The diffusion and infusion of IT, however, is a complex process that is influenced by numerous factors such as perceived characteristics of the innovation, subjective norms, stages of adoption, user competence, and implementation processes and organisational factors. Each factor has a direct effect on IT diffusion. Other findings suggest that migration costs, early of adoption, top management support and organisational size are positively associated with diffusion. However, advocacy by middle management is seen to have no positive effect on the success of implementation, but rather, having the right organisational and individual incentives could cause a widespread adoption. It has been observed that what limits the speed of usage is the lack of information available about the new technology, how to use it and what it does.

Corporate Culture Classification

The corporate culture classification has been carried out in different manners. Two type of classification is being discussed here.

A) Corporate Tribes Model of Organisational Culture

This is one of the most popular and influential typologies for overall culture. This classification suggests that corporate culture can be understood and managed by identifying four different "tribes": Tough-Guy/Macho, Work Hard/Play Hard, Bet-Your-Company, and Process. The degree of risk associated with company activities and the speed of feedback from the environment are the determining factors as to which quadrant best describes the overall culture of an organisation.

Bet-Your-Company organisations operate in a high risk/slow feedback environment typified by the phrase "Play it Safe". Typical industries include oil, drugs, aerospace, and public utilities. Large capital investments are usually required and the results from those investments are not usually known for a long time. A clear example would be NASA's development of the space shuttle.

The ritual of this culture *is* the business meeting. Important issues get full discussion. Decision-making is top-down once all the inputs are in. Actions are measured and deliberate. Once the importance of the IS plan is evident, specific decisions are made by top management and the plan starts becoming a reality. The decision makers have a great deal of character and self-confidence, which should enhance good follow-through on decisions. Also people in this culture become highly dependent on one another (they never "burn any bridges"). This implies better than average co-operation and communication between departments during the implementation effort.

Tough-Guy / Macho organisations have a high risk / quick feedback environment typified by the phrase “Find a mountain and climb it”. Typical industries include advertising, entertainment, and construction. Large capital outlays are usually required up front and the results (feedback) are usually known rather quickly. "Go for it all" decisions would fit the Tough-Guy/Macho representation.

The immediate feedback of this culture fosters a short-term perspective. The youth of many people typically in this type of culture does not support a strong planning orientation. These factors lead to difficulty in implementing an IS plan. Speed, not endurance is often the focus. Not taking an action, however, is as important as taking one. There is also extremely strong internal competition which breeds individualism and weak communication, another challenge for successful implementation of the IS plan.

Work Hard/Play Hard firms operate in a low risk/quick feedback environment and can be described by the phrase “Find a need and fill it”. Typical industries include retail and sales organisations. It is usually not very expensive to have a salesman make a particular sales call (low risk), but the feedback is rather immediate (quick feedback).

This is an action-oriented culture. Amount is more important than quality (e.g. sales). Listing the number of benefits of an IS plan will foster more commitment than giving details on a few benefits. Immediate benefits must be highlighted whenever possible. Success comes from persistence.

Process organisations operate in a low risk/slow feedback environment typified by the phrase "Be perfect". Typical industries include banking, insurance, and government departments. The process culture is exemplified by accounting departments and large, bureaucratic organisations where employees frequently focus on how they do something rather than on what they do.

Benefits and projected results of the IS plan must be clearly stated. Policies and procedures are critical to a successful IS plan in a process culture. Everything must be put into a memo and/or documented. Job titles play an important role in process culture, so as new responsibilities are created or delegated, careful consideration should be given to job title and perceived status.

B) Marketing and Production-oriented Corporate Cultures

In model we define two corporate cultures, marketing and production. Marketing cultures include a market orientation where organisations develop and maintain a viable fit between the organisations’ objectives, skills and resources to the changing market opportunities. In effect, market-oriented organisations design their products and service offerings to meet customer needs with a profit. Business success depends on effective analysis of marketing opportunities, researching and selecting target markets, designing marketing strategies, planning marketing programs and organizing, implementing and controlling the marketing effort. Corporate culture is “the single most important determinant of a company’s ability to adapt to market forces.”

The production-oriented businesses on the other hand, concentrate on achieving high production efficiency, low costs and mass distribution. They operate on the assumption that consumers prefer products that are widely available and inexpensive. Success is based on technological efficiency through cost cutting. Customer-oriented culture serves to make organisations more responsive to customer needs, whereas a competitor-oriented organisation works to perform well relative to the competition instead of profit maximisation or market share.

Production Orientation Culture

Production orientation, even though one of the oldest concepts in business, is still evident in high capital intensive industries and where demand exceeds supply. It is especially useful when consumers favour products that are available and highly affordable. In such circumstances, businesses can focus on improving production and distribution efficiencies. Manufacturing industries elected to manufacture goods based on their ability to be produced stressing standardisation and specialisation. The challenge becomes lies in finding ways to promote the products to potential purchasers in such a way as to create a perceived need for the good in the minds of potential buyers. Today, the advertising industry still finds itself constantly battling social critics who suggest that advertising, especially as practised in several countries, creates false needs, resulting in society's unnecessary expenditures for products or services. That are not needed.

Today, even the "best" firms sometimes backslide into a production orientation because in today's highly competitive markets it is often difficult to keep up with changing customer needs, beat aggressive competitors to the punch, find the right focus that matches the firm's objectives and resources to market opportunities and offer customers superior value.

Market Orientation Culture

The dynamic nature of the marketplace needs requires a continuous tracking and responsiveness of these needs with superior value in a consistent manner at a profit. A market-oriented organisation generates market intelligence, disseminates the intelligence across departments and provides the appropriate response to the needs of the market at a profit. The strategy is to survey markets to identify unfulfilled needs and then to produce products that satisfy those unmet needs. It is believed that if a product or service sufficiently satisfies consumers, the product or service will basically sell itself because people with the need will seek it for fulfillment. To be effective, more resources are required to focus on what potential consumers want and then translate product traits, packaging characteristics, price levels or availability of products to the consumers. Though market orientation has been posited to lead to greater customer satisfaction and organisational commitment of employees, arguments have been advanced to the effect that a market orientation may have a strong or weak effect on business performance. This depends on the environmental conditions such as market turbulence and competitive intensity. For an organisation to be considered market oriented, it must possess three behavioural components - customer orientation, competitor orientation and inter-functional coordination- and two decision criteria: long-term focus and a profit objective.

Perceived Effectiveness of IT Adoption

Perceived effectiveness of IT adoption is the extent to which individuals believe that the adoption of IT has been successful. Despite remarkable advances in information technology, many IT projects still fall short of performance expectations. A growing share of these implementation failures is caused by non-technical factors. Technology implementation success could be improved with active top management support, clear implementation goals and user participation and training. Other success factors include a good understanding of the intended end-users, their tasks and the interdependencies between the two, together with the appropriate business strategy. This should lead to adding value to the firm and positive influences on user behaviour.

Unfortunately, IT success can sometimes be elusive. An effective IT application is expected to improve performance, but if poorly planned, developed or implemented without due recognition of the need to increase human resource effectiveness, it can breed disaster and retard individual and/or group performance.

IT success correlates with the perceived performance and importance of these factors in each firm. Though different firms have different levels of appreciation of importance of performance factors, their overall attitude toward IT is strongly influenced by how well those factors are handled. The firms that concentrate their resources in the most important areas will achieve greater success than those that spread their resources too thinly. Performance factors include: 1) functioning of existing transaction/reporting systems, 2) linkage to strategic processes of the firm, 3) the amount and quality of user participation, 4) the responsiveness to new systems needs, 5) the ability to respond to end-user computing needs, 6) IS staff quality, and 7) the reliability of services. Other factors include identity, significance, autonomy and feedback.

4.7 DECISION MANAGEMENT WITH INFORMATION SYSTEMS

Decision-making is the cognitive process of selecting a course of action from among multiple alternatives. Every decision-making process produces a final choice. It can be an action or an opinion. It begins when we need to do something but we do not know what. Therefore decision-making is a reasoning process, which can be rational or irrational, and can be based on explicit assumptions or tacit assumptions. Common examples include shopping, deciding what to eat, and deciding whom or what to vote for in an election or referendum.

Decision-making is said to be a psychological construct. This means that although we can never "see" a decision, we can infer from observable behavior that a decision has been made. Therefore, we conclude that a psychological event that we call "decision making" has occurred. It is a construction that imputes commitment to action. That is, based on observable actions, we assume that people have made a commitment to effect the action.

Structured rational decision-making is an important part of all science-based professions, where specialists apply their knowledge in a given area to making informed decisions. For example, medical decision-making often involves making a diagnosis and selecting an appropriate treatment. Some research using naturalistic methods shows, however, that in situations with higher time pressure, higher stakes, or increased ambiguities, experts use intuitive decision making rather than structured approaches, following a recognition primed decision approach to fit a set of indicators into the expert's experience and immediately arrive at a satisfactory course of action without weighing alternatives.

Information fuels the new economy and plays an essential role in developing and maintaining a sustainable competitive advantage. The demands on a business today - increased global competition, lower barriers to entry, lower profit margins - are creating an ever-increasing need for access to data. The ability to get the right information to the right people at the right time is, therefore, more important than ever; however, the sheer volume of available data makes such a proposition more challenging than ever. Organisations that are the most successful at collecting, evaluating and applying information are consistently the leaders in their respective industries. The ability to act faster and more effectively than the competition can be the defining advantage in today's marketplace and the means for successfully managing customer relationships in the long run.

Managers and executives are judged, hired and fired by their performance against a variety of business goals and challenges, but they are made primarily in two ways: by the skills they possess in managing people and by the quality of their decisions.

Due to the large number of considerations involved in many decisions, *decision support systems* have been developed to assist decision makers in considering the implications of various courses of action. They can help reduce the risk of human errors. The systems, which try to realise some human/cognitive decision-making functions, are called Intelligent Decision Support Systems (IDSS).

Decision making style

According to behaviouralists the decision making process depends to a significant degree on cognitive style, which can be divided in four bi-polar dimensions. The terminal points on these dimensions are: thinking and feeling; extroversion and introversion; judgement and perception; and sensing and intuition. A person's decision-making style is based largely on how they score on these four dimensions. For example, someone who scored near the thinking, extroversion, sensing, and judgement ends of the dimensions would tend to have a logical, analytical, objective, critical, and empirical decision making style.

Cognitive and personal biases in decision-making

It is generally agreed that biases can creep into our decision making processes, calling into question the correctness of a decision. Below is a list of some of the more common cognitive biases.

Selective search for evidence: We tend to be willing to gather facts that support certain conclusions but disregard other facts that support different conclusions.

Premature termination of search for evidence: We tend to accept the first alternative that looks like it might work.

Conservatism and inertia: Unwillingness to change thought patterns that we have used in the past in the face of new circumstances.

Experiential limitations: Unwillingness or inability to look beyond the scope of our past experiences; rejection of the unfamiliar.

Selective perception: We actively screen-out information that we do not think is salient.

Wishful thinking or optimism: We tend to want to see things in a positive light and this can distort our perception and thinking.

Choice-supportive bias: occurs when we distort our memories of chosen and rejected options to make the chosen options seem relatively more attractive.
Recency: We tend to place more attention on more recent information and either ignore or forget more distant information.

Repetition bias: A willingness to believe what we have been told most often and by the greatest number different sources.

Anchoring and adjustment: Decisions are unduly influenced by initial information that shapes our view of subsequent information.

Groupthink: Peer pressure to conform to the opinions held by the group.

Source credibility bias: We reject something if we have a bias against the person, organisation, or group to which the person belongs: we are inclined to accept a statement by someone we like.

Incremental decision-making and escalating commitment: We look at a decision as a small step in a process and this tends to perpetuate a series of similar decisions. This can be contrasted with **zero-based decision-making**.

Inconsistency: The unwillingness to apply the same decision criteria in similar situations.

Attribution asymmetry: We tend to attribute our success to our abilities and talents, but we attribute our failures to bad luck and external factors. We attribute other's success to good luck, and their failures to their mistakes.

Role fulfillment: We conform to the decision-making expectations that others have of someone in our position.

Underestimating uncertainty and the illusion of control: We tend to underestimate future uncertainty because we tend to believe we have more control over events than we really do. We believe we have control to minimize potential problems in our decisions.

Faulty generalizations: In order to simplify an extremely complex world, we tend to group things and people. These simplifying generalizations can bias decision-making processes.

Ascription of causality: We tend to ascribe causation even when the evidence only suggests correlation. Just because birds fly to the equatorial regions when the trees shed their leaves, does not mean that the birds migrate *because* the trees shed their leaves.

Decision making in groups

Decision-making in groups is sometimes examined separately as process and outcome. Process refers to the interactions among individuals that lead to the choice of a particular course of action. An outcome is the consequence of that choice. Separating process and outcome is convenient because it helps explain that a good decision making process does not guarantee a good outcome, and that a good outcome does not presuppose a good process. Thus, for example, managers interested in good decision-making are encouraged to put good decision-making processes in place. Although these good decision making processes do not guarantee good outcomes, they can tip the balance of chance in favour of good outcomes.

A critical aspect for decision-making groups is the ability to converge on a choice.

Politics is one approach to making decisions in groups. This process revolves around the relative power or ability to influence individuals in the group. Some relevant ideas include coalitions among participants as well as influence and persuasion. The use of politics is often judged negatively, but it is a useful way to approach problems when preferences among actors are in conflict, when dependencies exist that cannot be avoided, when there are no super-ordinate authorities, and when the technical or scientific merit of the options is ambiguous.

In addition to the different processes involved in making decisions, groups can also have different decision rules. A decision rule is the approach used by a group to mark the choice that is made.

- *Unanimity* requires everyone to agree on a given course of action, and thus imposes a high bar for action. *Juries* in criminal trials commonly use unanimity.

- *Majority* requires support from more than 50% of the members of the group. Thus, the bar for action is lower than with unanimity and a group of “losers” is implicit to this rule.

- *Consensus decision-making* tries to avoid “winners” and “losers”. Consensus requires that a majority approve a given course of action, but that the minority agrees to go along with the course of action. In other words, if the minority opposes the course of action, consensus requires that the course of action be modified to remove objectionable features.

  - *Sub-committee* involves assigning responsibility for evaluation of a decision to a sub-set of a larger group, which then comes back to the larger group with recommendations for action. Using a sub-committee is more common in larger governance groups, such as a legislature. Sometimes a sub-committee includes those individuals most affected by a decision, although at other times it is useful for the larger group to have a sub-committee that involves more neutral participants.

Less desirable group decision rules are:

- *Plurality*, where the largest block in a group decides, even if it falls short of a majority.

- *Dictatorship*, where one individual determines the course of action.

Plurality and dictatorship are less desirable as decision rules because they do not require the involvement of the broader group to determine a choice. Thus, they do not engender commitment to the course of action chosen. An absence of commitment from individuals in the group can be problematic during the implementation phase of a decision.

There are no perfect decision making rules. Depending on how the rules are implemented in practice and the situation, all of these can lead to situations where either no decision is made, or to situations where decisions made are inconsistent with one another over time.

Principles

The ethical principles of decision making vary considerably. Some common choices of principles and the methods which seem to match them include:

- The most powerful person/group decides
  - Method: dictatorship or oligarchy

- Everyone participates in a certain class of meta-decisions
  - Method: parliamentary democracy

- Everyone participates in every decision
  - Direct democracy, consensus decision making

There are many grades of decision-making, which have an element of participation. A common example is that of institutions making decisions, which affect those they are charged to provide for. In such cases an understanding of what participation, is crucial to understand the process and the power structures at play.

Decision making in business and management

In general, business and management systems should be set up to allow decision making at the lowest possible level.

Several decision-making models for business include:

- Analytic Hierarchy Process — procedure for multi-level goal hierarchy
- Buyer decision processes — transaction before, during, and after a purchase
- Complex systems — common behavioural and structural features that can be modeled.
- Corporate finance:
  - o The investment decision
  - o The financing decision
  - o The dividend decision
  - o Working capital management decisions.
- Cost-benefit analysis — process of weighing the total expected costs *vs*. the total expected benefits.
- Decision trees
  - o Program Evaluation and Review Technique (PERT)
  - o Critical path analysis
  - o Critical chain analysis.
- Force field analysis — analysing forces that either drive or hinder movement toward a goal.
- Grid Analysis — analysis done by comparing the weighted averages of ranked criteria to options. A way of comparing both objective and subjective data.
- Linear programming — optimisation problems in which the objective function and the constraints are all linear.
- Min-max criterion.
- Model (economics) — theoretical construct of economic processes of variables and their relationships.
- Monte Carlo method — class of computational algorithms for simulating systems
- Morphological analysis — all possible solutions to a multi-dimensional problem complex
- Optimisation
  - o Constrained optimisation
- Paired Comparison Analysis — paired choice analysis
- Pareto Analysis — selection of a limited number of tasks that produce significant overall effect.
- Scenario analysis — process of analysing possible future events
- Six Thinking Hats — symbolic process for parallel thinking
- Strategic planning process — applying the objectives, SWOTs, strategies, programs process.
- Ubiquitous command and control is a concept for dynamic decision making based on "agreement between an individual and the world", and "agreements between individuals".

Making profitable business decisions faster and with greater agility is both a challenge and a goal for most organisations. But many companies still rely on manual decision-making processes that often prohibit consistency and efficiency. In some cases, they are completely unaware of valuable opportunities for cost-cutting or driving revenue. And it's not because they don't have the right data – it's because they don't know how to leverage and maximize it.

Over the last several years, more sophisticated business intelligence technology has helped companies improve their data analysis and reporting capabilities. It has also extended data analysis responsibilities to more end-users within the organisation (we've all heard the phrase BI for the casual user'). These are remarkable achievements. But forward-thinking companies will need to move from just managing data properly to capitalising on it. A number of new trends and best practices can help companies learn more from their data so they can make better business decisions, automatically.

Research in Psychology and decision sciences has challenged the assumption that people apply rational principles in making decisions that work to optimise expected results. This descriptive, empirical research has catalogued many of the biases that enter into decision-making. Managers often seek to mitigate uncertainty by any means before committing to a decision. Managers make judgements by making adjustments from some initial value, even if that initial value is based on totally random information. Decision-making processes need to be improved, but which processes, are the best candidates for improvement?

Strategic vs. Operational Decision Making

There are two types of decisions — operational and strategic. Strategic decisions have broad organisational scope but are infrequent, while operational decisions have more restricted scope but repeat frequently. IDC research shows that capturing and automating decision-making processes for repeatable, operational decisions are making progress.

Here are some examples of operational decisions:

- Do we extend credit to this customer?
- Are these transactions evidence of fraud?
- How can we reroute this shipment to meet the promised delivery date?
- What book do we recommend to this customer?
- Should this supplier be on the approved list?

By contrast, here are examples of strategic decisions:

- Do we acquire company X or company Y?
- Do we target retail or energy companies as an added vertical?
- Is it time to discontinue a product line or to launch a new one?

Strategic decisions are important. However, because they are infrequent, there is little opportunity to apply lessons learned on an ongoing basis and to provide software-based automation to support such a process. That is not the case with operational decisions which are repeatable.

Here are examples of operational decision-making initiatives across a variety of industries:

National Bank: Customer segment managers (formerly managers for individual products) meet every Monday, armed with the output of buyer behaviour models, to decide which products to offer to each segment.

Manufacturer of Electronic Devices and Components: In the R&D division, best practices are being captured to determine which lines of research to continue and which to halt - resulting in significant savings in R&D expenses.

Hewlett-Packard: An analysis of PC warranty claims provides an early warning of product defects, enabling remedial actions in the manufacturing process and proactive communications to customers.

Banco Espirito Santo: This Company deployed an early warning system to detect actions leading to customer attrition. By using predictive modeling software, they were able to improve "at-risk" banking customer retention by 50 per cent.

Decision Support Systems

Decision support systems are a class of computerized information systems or knowledge based systems that support decision-making activities. The concept of a *decision support system* (DSS) is extremely broad. A DSS can take many different forms and the term can be used in many different ways.

On the one hand, a DSS is broadly defined as "a computer-based system that aids the process of decision making." In a more precise way, it has been defined as "an interactive, flexible, and adaptable computer-based information system, especially developed for supporting the solution of a non-structured management problem for improved decision making. It utilises data, provides an easy-to-use interface, and allows for the decision maker's own insights."

Other definitions, which fill the gap between these two extremes, are:

- DSS couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions ("DSS are computer-based support for management decision makers who are dealing with semi-structured problems").

- DSS are "interactive computer-based systems that help decision makers utilise data and models to solve unstructured problems."

- The term *decision support system* remains a useful and inclusive term for many types of information systems that support decision making.

As of now, there is no universally accepted definition of DSS.

Additionally, the specifics of it are what make it less generalised and more detailed. In addition, a DSS also is a specific Software application that helps to analyse data contained within a customer database. This approach to customers is used when deciding on target markets as well as customer habits. This may be noticed this specific example, that DSS can be used for more than just organisation.

Classification of Decision Support Systems

As with the definition, there is no all-inclusive classification of DSS either. Different authors propose different classifications.

At the user-level, differentiation may be passive, *active*, and *cooperative DSS*.

- A **passive DSS** is a system that aids the process of decision-making, but that cannot bring out explicit decision suggestions or solutions.

- An **active DSS** can bring out such decision suggestions or solutions.

- A **cooperative DSS** allows the decision maker (or its advisor) to modify, complete, or refine the decision suggestions provided by the system, before sending them back to the system for validation. The system again improves, completes, and refines the suggestions of the decision maker and sends them back to him/her for validation. The whole process then starts again, until a consolidated solution is generated.

At the *conceptual level*, differentiation may be *communication-driven DSS*, *data-driven DSS*, *document-driven DSS*, *knowledge-driven DSS*, and *model-driven DSS*.

- A **model-driven DSS** emphasizes access to and manipulation of a statistical, financial, optimisation, or simulation model. Model-driven DSS use data and parameters provided by DSS users to aid decision makers in analysing a situation, but they are not necessarily data intensive. Dicodess is an example of an open source, model-driven DSS generator.

- A **communication-driven DSS** supports more than one person working on a shared task; examples include integrated tools like Microsoft's NetMeeting or Groove.

- A **data-driven DSS** or data-oriented DSS emphasizes access to and manipulation of a time series of internal company data and, sometimes, external data.

- A **document-driven DSS** manages, retrieves and manipulates unstructured information in a variety of electronic formats.

- A **knowledge-driven DSS** provides specialised problem solving expertise stored as facts, rules, procedures, or in similar structures.

At the system level, differentiation may be *enterprise-wide DSS* and *desktop DSS*.

- *Enterprise-wide DSS* are linked to large data warehouses and serve many managers in a company.

- *Desktop, single-user DSS* are small systems that reside on an individual manager's PC.

When classifying DSS, it can be viewed as very broad or very narrow. Since it is difficult to classify DSS into only one classification, the taxonomy cannot exactly be pinpointed.

However, if it is necessary, a DSS is certainly classified into precise, scientific organisational software that not only contributes, but also performs decision-making steps in order to ease the pressure for its users. The fact is in a few words, DSS is organisational decision-making software.

Architectures

Once again, different authors identify different components in a DSS. Three fundamental components of DSS can be categorized as: (a) the database management system (DBMS), (b) the model-base management system (MBMS), and (c) the dialog generation and management system (DGMS). These three components can be described in more detail: the Data Management Component stores information (which can be further subdivided into that derived from an organisation's traditional data repositories, from external sources such as the Internet, or from the personal insights and experiences of individual users); the Model Management Component handles representations of events, facts, or situations (using various kinds of models, two examples being optimisation models and goal-seeking models); and the User Interface

Management Component is of course the component that allows a user to interact with the system.

Academics and practitioners have discussed building DSS in terms of four major components: (a) the user interface, (b) the database, (c) the model and analytical tools, and (d) the DSS architecture and network.

Hättenschwiler (1999) identifies five components of DSS: (a) users with different roles or functions in the decision making process (decision maker, advisors, domain experts, system experts, data collectors), (b) a specific and definable decision context, (c) a target system describing the majority of the preferences, (d) a knowledge base made of external data sources, knowledge databases, working databases, data warehouses and meta-databases, mathematical models and methods, procedures, inference and search engines, administrative programs, and reporting systems, and (e) a working environment for the preparation, analysis, and documentation of decision alternatives.

Marakas (1999) proposes a generalised architecture made of five distinct parts: (a) the data management system, (b) the model management system, (c) the knowledge engine, (d) the user interface, and (e) the user(s).

There are several ways to classify DSS applications. Not every DSS fits neatly into one category, but a mix of two or more architecture in one. The six frameworks in which DSS can be classified are: Text-oriented DSS, Database-oriented DSS, Spreadsheet-oriented DSS, Solver-oriented DSS, Rule-oriented DSS, and Compound DSS.

The support given by DSS can be separated into three distinct interrelated categories: Personal Support, Group Support and Organisational Support.

Additionally, DSS can be classified in a similar way. The build up of a DSS is classified into a few characteristics. (1) Inputs: this is used so the DSS can have factors, numbers, and characteristics to analyze. (2) User knowledge and expertise: This allows the system to decide how much it is relied on, and exactly what inputs must be analysed with or without the user. (3) Outputs/Feedback: This is used so the user of the system can analyse the decisions that may be made and then potentially (4) make a decision: This decision making is done by the DSS', however, it is ultimately made by the user in order to decide on which criteria it should use.

Applications

As mentioned above, there are theoretical possibilities of building such systems in any knowledge domain.

One of the examples is clinical decision support system for medical diagnosis. Other examples include a bank loan officer verifying the credit of a loan applicant or an engineering firm that has bids on several projects and wants to know if they can be competitive with their costs.

A specific example concerns the Canadian National Railway system, which tests its equipment on a regular basis using a Decision Support System. A problem faced by any railroad is worn-out or defective rails, which can result in hundreds of derailments per year. Under a DSS, CN managed to decrease the incidence of derailments at the same time other companies were experiencing an increase.

DSS has many applications that have already been spoken about. However, it can be used in any field where organisation is necessary. Additionally, a DSS can be designed to help make decisions on the stock market, or deciding which area or segment to market a product toward. DSS has endless possibilities that can be used anywhere and anytime, for its decision making needs.

Check Your Progress 1

1) State whether True or False

   i) Due to present day developments in Information systems, current expectations are for "Now economy" and "Integrate economy". True ☐ False ☐

   ii) Under the four layer system for empirical studies, in the first layer based on the input data, abstract user properties are inferred.

$$\text{NPV} = \sum_{t=1}^{N} \frac{C_t}{(1+i)^t} - \textit{Initial Investment}$$

   where NPV = Net Present value, C=Cash flow, i=rate of interest, n=time period of the project and t=time period up to which NPV is to be calculated. True ☐ False ☐

   iii) The internal rate of return (IRR) is defined as the discount rate that gives a net present value (NPV) of zero. True ☐ False ☐

   iv) As per Corporate Tribes Model of Organisational Culture, corporate culture can be understood and managed by identifying four different "tribes": Tough-Guy/Macho, Work Hard/Play Hard, Bet-Your-Company, and Customer Friendly. True ☐ False ☐

   v) All authors agree to same classification for decision support systems. True ☐ False ☐

2) Answer the following:

   a) What do we mean by 'Now Economy'?

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   b) How many kinds of empirical studies can answer the basic questions of Information / Artificial Intelligence systems? What are these?

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   c) Indicate the types of benefits of any information system project. Indicate four elements of costs and four elements of each type of benefits.

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   d) For which situation Real Option Pricing Model is considered and how many options categories are there? List these categories.

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   e) What are the indirect costs which need to be considered for total cost of ownership (TCO)?

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f) List the established factors of corporate culture having deep impact on the Information system.

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4.8 SUMMARY

With this unit, we have completed the first block on this subject and thus rounded off our discussion on fundamentals of organisations, Management and Information Systems. We have covered what factors need be looked into for planning, evaluating and implementing information systems at organisational and management levels.

In this unit our discussion must have helped you to understand business value of information systems. We have discussed, besides financial evaluation, the human angle as well as other direct and indirect costs and benefits to be kept in mind in estimating total cost of an information system.

We have also completed our discussion on a very important topic i.e., decision making and how information system is providing support in this domain.

In the next block we will move on to finer aspects relating to Information Systems.

4.9 SOLUTIONS / ANSWERS

1) i) True ii) False iii) False iv)True v)False vi) False.

2)

a) By "Now economy", we mean a real-time enterprise – an organisation is expected to react instantaneously to changes in its business. They are expected to provide "instant gratification" to customers. Products and services are expected to be delivered by them to customers: anytime (24/7), anywhere (global reach), any form (mass customisation), and any price (dynamic pricing depending on real-time supply-demand adjustment). The organisation will need Real-time Monitoring, Reporting and Decision-making.

b) Four kinds of empirical studies: and their combination provide answers to the basic research questions: The kind of empirical studies are:

- *exploratory studies* that yield causal hypotheses;
- *assessment studies that establish baselines, ranges,*
- *benchmark that manipulate experiments to test hypotheses about causal influences; and*
- *observation experiments (or quasi-experiments) that disclose effects of factors on measured variables without random assignment of treatments.*

c) There are two types of benefits (i) Tangible and (ii) Intangible**.** Four elements each of the cost and of the two types of benefits are as indicated below:

Costs	Benefits (Intangible)
Hardware	Improved operations
Software	Better asset utilisation
Services	Better organisational planning
Manpower	Better customer satisfaction
Benefits (Tangible)	
Increased Productivity	
Reduced manpower	
Lower vendor services cost	
Lower Clerical overheads	

d) Real Option Pricing Model is considered for the strategic decision with respect to whether the project needs to be taken up now or later and when it will be more beneficial.

Real options model has six categories based upon the type of flexibility provided. The six categories are: the option to defer; the option for staged investments; the option to change scale; the option to abandon; the option to switch; and the option to grow.

e) The Indirect costs which need to be considered for total cost of ownership (TCO) are:

- *Operations management,*
- *Systems management,*
- *Maintenance of hardware and software components,*
- *Ongoing license fees,*
- *Upgrade costs,*
- *User support,*
- *Environmental factors affecting the system's external requirements for proper operation, such as air conditioning, power supply, housing, and floor space.*

f) The established factors of corporate culture having deep impact on the Information system are:

- Extent of Application
- User Participation
- Perceived Ease of Use
- Perceived Usefulness
- Adoption Diffusion.

4.10 FURTHER READINGS/REFERENCES

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