UNIT 1 ORGANISATIONAL OVERVIEW

Structure **Page No.**

1.0 INTRODUCTION

Modern organisations are totally and irreversibly dependent on information systems in virtually every functional area. Information systems are a core enabling technology in sectors such as business, manufacturing, communications, education, health care, and government, to name just a few. This growing dependence brings fresh demands for more efficient and timely development of ever more complex systems that must be complete and correct, and that must be capable of evolution to meet changing requirements. Information and telecommunication technologies (IT) play crucial roles in the organisation and management of global businesses. In some cases information systems are enabling fundamental shifts in the structure of global markets. Recognising the importance of the link between organisations, management and information systems, all aspects of organisations are being covered in this unit while management and information systems will be covered in subsequent units.

In this unit, you will be made familiar with the type of organisations and the key factors involved in the design of the organisation structures. Merits and demerits of the various organisations structures will also be discussed. You will be provided insight to the functioning and characteristics of the organisation as well as to the various stages of existence and health of the organisation.

1.1 OBJECTIVES

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

- define the organisation and its types;
- understand the principals of organisation structure design;
- understand the common and unique characteristics of the organisations;
- understand the functions and life cycle of an organisation, and
- appreciate the merits and demerits of tall and vertical organisation structures.

1.2 ORGANISATION AND ITS TYPES

The term **organisation** has been defined in several ways. An *Organisation* can be defined as a stable, formal social structure that uses resources and produces them to

produce output. This output could be a physical product or service.
Leavitt (1962) defined *Organisation* as a specific configuration of structure, people, task and techniques. *Structure* describes the form of departments, hierarchy and committees. It influences the organisation's efficiency and effectiveness. *People* refer to the skills, attitudes and social interaction of the members of the organisation. *Task* refers to the goals of the individual and the organisation. *Techniques* refer to the methodical approach used to perform tasks. Organisational structure thus refers to the institutional arrangements and mechanisms for mobilising human, physical, financial and information resources at all levels of the system.

Organisation is also defined as a system incorporating a set of sub-systems (Katz and Kahn, 1978). These sub-systems are related group of activities, which are performed to meet the objectives of the organisation.

Numerous theorists have viewed organisation differently. However, all definitions usually contain five common characteristics:

- Composed of individuals and groups of individuals;
- Oriented towards achieving common goals;
- Differential functions;
- Intended rational coordination, and
- Continuity through time.

Organisations at a macro level can be divided in three ***types***

- Extraction,
- Manufacturing including Construction, and
- Services.

These three types have distinct features. Extraction organisations produce goods by extracting them from the earth. Examples of such organisations are Agriculture, Mining, Oil and Gas exploration and producing companies. The manufacturing organisations produce goods by conversion or by processing of one type of goods designated as raw materials into other type of goods designated as finished goods. Examples of this type are Car manufacturing, Fertilizer manufacturing, pharmaceutical and drug manufacturing companies etc. The service organisations do not produce any tangible goods but produce services only. Services are intangible items having no shape or colour. Banking, Insurance, Transportation, Universities, Hospitals, Management Consultancy, Legal Firms etc. are example of these types of organisations. These three types of organisations have quite distinct structure, characteristics and functions.

Within each of the above three macro level classification for Types of organisations, further classification is required to be based on the **Industries** for example, Engineering Industry, Chemical Industry, Food Industry, Banking and Finance etc. Each Industry provides its own environment, technologies, skill sets, specialisation, culture and business processes to the organisations in its ambit. *Table 1* shows three basic types of organisations and various industries covered in these.

It is interesting to note that sometimes *three types* of organisations may be part of a single *Industry* and may form one organisation. Steel Authority of India is one such example, which deals with not only mining and manufacturing but also trading of the product manufactured.

Table 1: Summary of Organisation Types and Industries

Sl.No.	Type of Organisation	Sl.No.	Type of Organisation
1.0	**Extraction**	3.4	Finance and Insurance
1.1	Agriculture	3.5	Wholesale Trade
1.2	Mining (including Oil & Gas)	3.6	Retail trade
2.0	**Manufacturing & Construction**	3.7	Information Technology
2.1	Process / Chemical	3.8	Health & Welfare
2.2	Engineering	3.9	Education
2.3	House Building	3.10	Real Estate
3.0	**Services**	3.11	Sports and Recreation
3.1	Transport	3.12	Travel & Tourism
3.2	Communication	3.13	Social
3.3	Government (Central & State)	3.14	Others

1.3 ORGANISATIONAL STRUCTURE

An *organsational structure* defines how job tasks are formally divided, grouped and coordinated. It defines what are the organisational components (units), their relationships and hierarchy. It portrays where formal authority and power are located and provides a "home" and identity for employees. The knowledge about organisation structure answers to:

- Who goes where?
- What do they do?
- What are the positions and how are they grouped?
- What is the reporting sequence?
- What is each person, and each unit, responsible for?
- How does authority/accountability flow?

Structure is thus an integral component of the organisation. It defines the arrangement and interrelationship of component parts and positions in an organisation. It provides guidelines on:

- Division of work into activities;
- Linkage between different functions;
- Hierarchy;
- Authority structure;
- Authority relationships, and
- Coordination with the environment.

Organisational structure may differ within the same organisation according to the particular requirements.

For designing an organisational structure, six key elements are required. These are:

a) **Work Specialisation:** Historically the underlying principal was that work could be performed more efficiently if employees are allowed to specialize. Today we use the term *work specialisation* or division of labour, to describe the degree to which tasks in the organisation are subdivided into separate jobs.

b) **Departmentalisation:** Once the jobs have been divided through work specialisation, these need to grouped together so that common tasks can be coordinated. The basis by which jobs are grouped together is called *departmentalsation*. One of the most popular ways of forming such groups is by functions like marketing, production, and finance etc.

c) **Chain of command:** The *chain of command* is an unbroken line of authority that extends from the top to lowest level and clarifies who reports to whom. It answers question for employees such as "To whom do I go if I have a problem?" and "To whom I am responsible?"

d) **Span of control:** How many employees can a manager efficiently and effectively direct? This question of span of control is important because to a large degree, it determines the number of levels and managers an organisation has. All things being equal, the wider or larger the span, the more efficient, is the organisation.

e) **Centralisation and Decentralisation:** The term centralisation refers to the degree to which decision-making is concentrated to a single point in the organisation. The concept includes only formal authority. Typically, if the top management makes all the key decisions, the organisation is termed as *centralised*. In contrast, if bulk of the decisions is allowed to be taken at the lower level, the organisation is termed as *decentralised*.

f) **Formalisation:** *Formalisation* refers to the degree to which jobs within the organisation are standardised. In case jobs are highly formalised, employees will have less freedom or discretion to carry out the jobs, but the jobs will have explicit methods and procedures to complete it.

Check Your Progress 1

1) State True or False.

(i) Indian Oil Corporation is an organisation of extraction type. True ☐ False ☐

(ii) Oil and Natural Gas Commission (ONGC) can be classified as manufacturing organisation. True ☐ False ☐

(iii) Organisation structure is an integral component of the organisation. True ☐ False ☐

(iv) The chain of command is a broken line of authority that extends from the top to lowest level and clarifies who reports to whom. True ☐ False ☐

(v) Formalisation refers to the degree to which jobs within the organisation are standardised. True ☐ False ☐

2) Answer the following:

(i) What are the types of organisations at macro level? What is the distinctive feature for each of these types?

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(ii) What are the six key elements required for designing an organizational structure?

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(iii) How 'Centralized Organisations' are different from 'Decentralized Organizations'? Give examples of each.

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1.4 ORGANISATIONAL CHARACTERISTICS

The operations of nearly all organizations — from the multinational corporation to a newly opened small set-up — are based on *division of labour*, a *decision-making structure*; and *rules and policies* which are referred as common **organisational characteristics.** The degrees of formality with which these aspects of business are approached vary tremendously within the business world, but these characteristics are inherent in any business enterprise that utilises the talents of more than one person.

Organisations practice *division of labour* both vertically and horizontally. Vertical division includes three basic levels — top, middle, and bottom. The main functions of top-managers is to draw strategic plans which may include long-term and short-term goals and also to monitor the current business with the help of middle-level managers. Middle-level managers convert the strategic plan set by top level managers into action plan and monitor day-to-day activities of lower level managers. Lower level managers act as per the action plans defined by the middle level managers and perform the specific activities as assigned to them.

Organisations also divide labour horizontally by defining task groups, or departments, and assigning workers with applicable skills to those groups. Line units perform the basic functions of the business, while staff units support line units with expertise and services. In general, line units focus on supply, production, and distribution, while staff units deal mostly with internal operations and controls or public relations efforts.

Decision-making structures, the second basic organisational characteristic, are used to organise authority. These structures vary from operation to operation in their degree of centralisation and decentralisation. Centralised decision structures are referred to as "tall" organisations because important decisions usually emanate from a high level and are passed down through several channels until they reach the lower end of the hierarchy. Conversely, flat organisations, which have decentralised decision-making structures, employ only a few hierarchical levels. Such organisations are typically guided by a management philosophy that is favourably disposed toward some form of employee empowerment and individual autonomy.

A formalised system of *rules and policies* is the third standard organisational characteristic. Rules, policies, and procedures serve as templates of managerial guidance in all sectors of organisational production and behaviour. They may document the most efficient means of accomplishing a task or provide standards for rewarding workers. Formalised rules provide managers with more time to spend on other problems and opportunities and help ensure that an organisation's various subsystems are working in concert. Poorly implemented rules, of course, can actually have a negative impact on business efforts to produce goods or services in a profitable or satisfactory manner.

Thus, organisations can be categorised as informal or formal, depending on the degree of formalisation of rules within their structures. In formal organisations, say researchers, management has determined that a comparatively impersonal relationship between individuals and the company for which they work is viewed as the best environment for achieving organisational goals. Subordinates have less influence over the process in which they participate, with their duties more clearly defined.

Informal organisations, on the other hand, are less likely to adopt or adhere to a significant code of written rules or policies. Instead, individuals are more likely to adopt patterns of behaviour that are influenced by a number of social and personal factors. Changes in the organisation are less often the result of authoritative dictate and more often an outcome of collective agreement by members. Informal

organisations tend to be more flexible and more reactive to outside influences. But some critics contend that such arrangements may also diminish the ability of top managers to effect rapid change.

Each organisation produces some *output* which may be physical goods or services by use of certain inputs / resource. *Resources* may be one or combination of men, material, machine and finance etc. *Table 2* gives the list of common characteristics of organisation.

Table 2: Summary of Common and Unique Characteristics of Organisation

Common Characteristics	Unique Characteristics
Formal Structure Principal of Division of labour Standard Operating Procedures Decision Making Process Use of Resources (Men, Machine, Material etc.) Output	Organisational Type Environment, Goals, Power Size of the Organisation Locations Involved Functions & Business Processes Technology

The two organisations are not the same. Organisations differ greatly in type, size, function, environment, technology and business processes etc. Such characteristics, which are unique for each organisation, are listed in *Table 2 Organisation Types* has already been discussed Section 1.2.

Organisations reside in *Environment* from which they draw resources and to which they provide goods or services. The effect of these environmental factors which may include stockholders, labour unions, government agencies, competitors, financial institutions, suppliers and customers (*Figure 1*). These factors change much faster than the organisations. For the sake of survival and profitability organisations / management have to cope and adjust to these factors and information system of the organisation plays a vital role in it. Depending upon the type of organisation and industry, each organisation has its own environment to take care of.

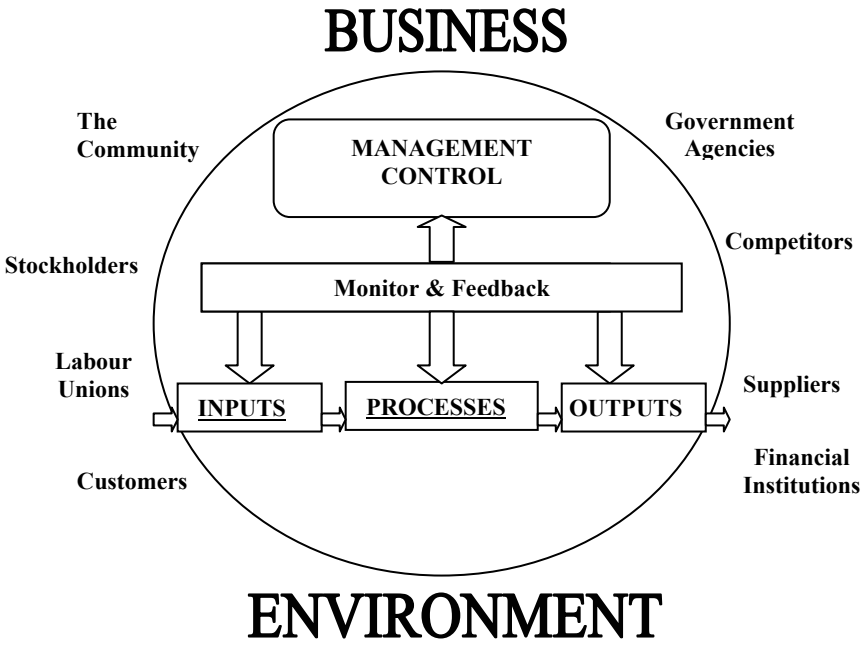

Figure 1: Organisation and environment

Environmental influences that affect the organisations can be categorised as either specific or general. The specific environment refers to the network of suppliers, distributors, government agencies, and competitors with which a business enterprise interacts. The general environment encompasses four influences that emanate from the geographic area in which the organisation operates. These are:

- *Cultural values*, which shape views about ethics and determine the relative importance of various issues.
- *Economic conditions*, which include economic upswings, recessions, regional unemployment, and many other regional factors that affect a company's ability to grow and prosper. Economic influences may also partially dictate an organisation's role in the economy.
- *Legal/political environment*, which effectively helps to allocate power within a society and to enforce laws. The legal and political systems in which an organisation operates can play a key role in determining the long-term stability and security of the organisation's future. These systems are responsible for creating a fertile environment for the business community, but they are also responsible for ensuring — via regulations pertaining to operation and taxation — that the needs of the larger community are addressed.
- *Quality of education*, which is an important factor in high technology and other industries that require an educated work force. Businesses will be better able to fill such positions if they operate in geographic regions that feature a strong education system.

Organisations differ, in their ultimate *Goals* and the type of *Power* used to achieve them. Some organisations have coercive goals, for example prisons; others have utilitarian goals, for example, business organisations. Still others have normative goals, for example, universities and religious groups.

Size and *number of locations* involved for the organisations result in different organisational shape, structures and procedures. *Business functions* and *process* have been discussed in detail in Unit 2.3. *Technology* adopted by the organisation has great bearing on work force and tasks. Newer Technology adopted by the competitors may put strains on any organisation. The nature of *Leadership* differs greatly from one organisation to another — some organisations may be more democratic or authoritative than others. Some organisations perform primary *Tasks* that could be reduced to formal rules that require little judgment like in case of manufacturing organisations, while consultancy firms have to perform non-routine tasks.

As can be seen in *Table 2*, list of unique characteristics is longer than the common characteristics. *It stands to reason that information systems will have different impacts on different type of organisations even if the technology adopted is same*. Only by close analysis and the appropriate design of the system suiting to the specific needs of the organisation will result in optimum results.

1.5 ORGANISATIONAL FUNCTIONS

Let us look at a organisations whose goal is to generate certain services and/or to produce goods (factories, service enterprises, etc.). The **organisational functions** of such organisations is **business**. Now let us look at the organisations of which goal is to bring about certain effects in its surrounding world (e.g., authorities, police, political parties, interest groups, trade unions, etc.). *Business* is definitely not the function of these organisations. Then there are organisations whose goal is to change individuals (e.g., schools, universities, hospitals, prisons). These types of organisations are also known as non-profit-organisations and business is not the function of these organisations also. We may notice that for authorities, prison and police the function is

Bureaucracy. We may also notice that for business organisations and for bureaucratic set ups constitution, management policies, procedures and system are different to quite some extent while in the same functionality group these may be similar. There are several different Functions for various organisations. It is difficult to list down all the functions in this changing and developing scenario, however, we can look at some important organisational functions described below:

a) Business organisations is an area of law that covers the broad array of rules governing the formation and operation of different kinds of entities by which individuals can organise to do business. The term is also used to describe the entities themselves. A variety of other terms are used fairly interchangeably to describe this area, including or **business associations**, **business forms**, and **business entities**. Reference to a "business" entity usually (though not always) indicates that entity's status as for-profit, as opposed to non-profit. In common law countries today, the most commonly addressed forms are:

- The sole proprietorship — this is, however, a single-person operation, and therefore not truly any kind of "organisation".
- The partnership, sometimes called a "general partnership".
- The limited partnership (LP).
- The limited liability partnership (LLP).
- The corporation.
- The limited liability company (LLC).

Less commonly used business forms include the limited liability limited partnership (LLLP), and the limited company (LC). Other types of business organisations, such as cooperatives, credit unions and publicly owned enterprises, can be established with purposes that parallel, supersede, or even replace the profit maximisation mandate of business corporations. There are large numbers of organisations in each of these forms of business.

b) Bureaucracy is a concept in sociology and political science referring to the way that the administrative execution and enforcement of legal rules is socially organised. This office organisation is characterised by standardised procedure, formal division of responsibility, hierarchy, and impersonal relationships.

Examples of everyday bureaucracies include governments, armed forces, corporations, hospitals, courts, ministries and schools.

c) Charity is the function of the *charitable trust*, which is organised to serve private or public charitable purposes. Charities may take the form of charitable trusts, companies or unincorporated associations.

Because of the benefits provided by charitable trusts, they are subject to certain benefits under trust law. For example, transfers of property to a charitable trust are usually exempt from the rule against perpetuities, which would otherwise operate to void a transfer made after a certain period. Furthermore, charitable trusts come under the doctrine of cypres, which holds that if the charity designated in the trust ceases to exist or otherwise becomes unable to carry out the purpose of the trust, and then the trust property can be transferred to another charity with a similar purpose.

d) International Cooperation or **Control** is the function for the organisation of international scope or character. There are two main types of international organisations:

- International intergovernmental organisations (IGOs) whose members are sovereign states or other intergovernmental organisations (like, the European Union), and
- Non-governmental organisations (NGOs), which are private organisations.

Generally and correctly used, the term international organisation is used to mean international governmental organisations only. Examples of such organisations are:

- United Nations, its specialised agencies, and associated organisations
- INTERPOL
- International Hydrographic Organisation
- World Trade Organisation.
- Universal Postal Union.

e) Mutual Cooperation is the function for the cooperative organisation or *society* (which is often, but not always, a company or business) based on the principle of mutuality. A mutual organisation or society is often simply referred to as *a mutual*.

A mutual exists with the purpose of raising funds (or money), from its membership or customers (collectively called its *members*), which can then be used to provide common services to all members of the organisation or society. A mutual is therefore owned by, and run for the benefit of its members — it has no external shareholders to pay in the form of dividends, and as such does not usually seek to maximize and make large profits or capital gains. Mutuals exist for the members to benefit from the services they provide. Profits made will usually be re-invested in the mutual for the benefit of the members, although some profit may also be necessary in the case of mutual to sustain or grow the organisation, and to make sure it remains safe and secure.

Various types of financial institutions around the world are mutuals, and examples include:

- Building societies
- Credit unions
- Friendly societies
- (Mutual) Insurance/Assurance companies
- Savings and loan associations
- Mutual savings bank
- Mutual bank.

Modern mutual financial institutions usually offer services very similar (if not the same) to those of a bank, except a mutual may pay higher interest rates on savings and deposit accounts, charge lower interest rates on mortgages and loans, have fewer or lower fees and charges on the services or products it offers, and the members who save and borrow with the mutual ultimately own the business.

f) Social, cultural, legal, and environmental advocacy functions from the goal of the *Non-governmental organisations (NGOs).* Such organisations are not part of a government and are not founded by states. NGOs are therefore typically independent of governments. Although the definition can technically include for-profit corporations, the term is generally restricted to social, cultural, legal, and environmental advocacy groups having goals that are primarily non-commercial. NGOs are usually non-profit organisations that gain at least a portion of their funding from private sources.

Because the label ‘NGO’ is considered too broad by some, as it might cover anything that is non-governmental, many NGOs now prefer the term private voluntary organisation (PVO) or Private Development Organisation (PDO).

A 1995 UN report on global governance estimated that there are nearly 29,000 international NGOs. National numbers are even higher: The United States has an estimated 2 million NGOs, most of them formed in the past 30 years. Russia has 65,000 NGOs. India has 2 million NGOs. Dozens are created daily. In Kenya alone, some 240 NGOs come into existence every year.

g) Collaborative Networks Function is the basis of a *Virtual Organisation.* A Virtual Organisation is any type of organisation that does not have a central geographical location and exists solely through telecommunication tools.

- A *Virtual Organisation* comprises a set of (legally) independent organisations that share resources and skills to achieve its mission / goal, but that is not limited to an alliance of profit enterprises. The interaction among members of the virtual organisation is mainly done through computer networks. A Virtual Organisation is a manifestation of Collaborative Networks.
- In business a Virtual Organisation is a firm that outsources the majority of its functions.

In grid computing, a *Virtual Organisation* is a group of individuals or institutions that share the computing resources of a "grid" for a common goal.

h) Pacifist functions that are pacifist principles of standing against war and aggression are promoted by the Pacifist organisation. Some organisations are concerned only with the removal of nuclear weapons from war although they may call for suspension of hostilities as well. Amongst other organisations are those which deal with other concerns but which have a strong pacific element. The examples of pacifist organisations are:

- Religious Society of Friends (Quakers)
- Mennonites
- Christian Peacemaker Teams
- Christian anarchism
- Fellowship of Reconciliation

Nuclear pacifist organisation:

- Pugwash
- CND

Organisations which cite pacifism as an aim:

- Green peace.

i) Collective function is promoted by a group of people who share or are motivated by at least one common issue or interest, or work together on a specific project(s) to achieve a common objective. Collectives are also characterized by attempts to share and exercise political and social power and to make decisions on a consensus-driven and egalitarian basis. Collectives differ from cooperatives in that they are not necessarily focused upon an economic benefit or saving (but can be that as well). A commune or intentional community, which may also be known as a "collective household", is a group of people who live together in some kind of dwelling or residence, or in some other arrangement (eg., sharing land). Collective households may be organised for a specific purpose (eg., relating to business, parenting, or some other shared interest). Collective consciousness is a term created by French social theorist Émile Durham that describes how an entire community comes together to share similar values. The term collective is sometimes used to describe a species as a whole, for example the *human collective*.

Types of collectives:

- Art collectives
- Activist collectives

- Environment collectives
- Health collectives
- Law collectives
- Music collectives
- Newspaper collectives
- Research collectives.

Check Your Progress 2

1) State True or False.

(i) Organisations practice *division of labour* both vertically and horizontally. Vertical division includes five basic levels. True ☐ False ☐

(ii) Organisations change much be faster than the Environment. True ☐ False ☐

(iii) Same information systems will have same impacts on different type of organisations if the technology adopted is same. True ☐ False ☐

(iv) Collaborative Networks function is the basis of a Virtual Organisation. True ☐ False ☐

(v) Business, International Cooperation, and Mutual Cooperation are examples of functions of organisations. True ☐ False ☐

2) Answer the following:

a) Indicate Four common and five unique characteristics of Organisation.

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b) Give three examples (names) of each of the following functional organisations: Business, Bureaucracy, Charity, Mutual Cooperation, and International cooperation.

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c) Give two examples of Hierarchical and Flat organisations.

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d) Explain the role that the Environment plays on the Organisation.

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1.6 LIFE CYCLE OF AN ORGANISATION

Organisations go through different phases of growth. For sustained growth, it is important to understand what phase of the organisational life cycle one is in. Many will enter decline unless there are transformational leaders who can renew the organisation. Different experts argue on how many phases there are in an organisational life cycle, but the **Five** most acceptable and distinct stages, which are easy to remember, are:

1) Startup,
2) Growth. This is sometimes divided into an early growth phase (fast growth) and maturity phase (slow growth or no growth). However, maturity often leads to.
3) Decline. When in decline, an organisation will either undergo,
4) Renewal, and
5) Failure.

Each of these phases present different management and leadership challenges that one must deal with.

The Start-up Phase

This phase commences from the time an entrepreneur conceives the idea of a particular business and for giving shape to the business, a management group is formed and a business plan is written. Resources are deployed and the organisation is established Start-up ends when business is declared open.

The Growth Phase

No organisation can remain stagnant for a long time as stagnancy for a long time leads to natural death for the organisation. So as a corollary to stagnancy, organisations to flourish must kick-start and grow. For entrepreneurs needing money to kick-start the business, the company goes into the growth phase once the investor writes the check. In the growth phase, one expects to see revenues climb, new services and products developed, more employees hired and so on. This growth phase has been divided into sub-phases of growth that is Childhood, Adolescence, Adulthood and Maturity. The management textbooks love to assume that sales grow each year. The reality is much different since a company can have both good and bad years depending on market conditions. Many companies have different types of programs relating to organisational development in place. Few actions, which need to be taken at each phase for better health of the organisation, are given in the following *Table 3:*

Table 3: Suggested Actions for Sustained Good Health of the Organization

Stage	Characteristics	Actions to Take
Start-Up Phase / Birth	An organisation is created and establishes its presence.	• Help develop the leadership skills of others within the organisation • Develop preliminary systems for the organisation
Growth Phase/ Childhood	An organisation begins to learn new skills and to build a solid, supportive organisational infrastructure.	• Invite and accept to nurture the organisational potential by more experienced leaders, organisations, and founders
Growth Phase/ Adolescence	An organisation expands the scope of its actions and learning as it goes.	• Experiment • Take on more difficult challenges • Take responsibility for action or inaction • Learn from and be mentored by those with more experience
Growth Phase/ Adulthood	An organisation assumes a greater level of responsibility.	• Take the lead on an issue even without significant credit • Take appropriate risks even if defeat is possible • Nurture and mentor organisations in their childhood and adolescence
Growth Phase/ Maturity	An organisation uses its legacy to strengthen the movement overall.	• Turn over responsibility to others • Share wisdom and experiences • Set an example for personal and organisational renewal
Renewal	An organisation resists the urge to stay comfortable.	• Develop a new strategic focus or new organisational leadership

The Decline Phase

In organisations that have been around for a few years, unless checked-in by the vigilant management complacency sets in or due to other reasons / dry rots as indicated below the organisation gets into the decline phase:

- Conflicting interests between various groups / departments, leading to decisions which are not in the best interest of the organisation;
- Poor team work;
- No strategic views or strategic views not being followed;
- Confusing roles and responsibilities;
- Repeated mistakes, no lesson learned from mistakes for correcting mistakes;
- Fire fighting at difficult times rather than long term corrective and preventive actions;
- Mistrust among various groups;
- Executive and employees driven by greed rather than inspiring vision;
- No respect for resources (time, money, men or machine).

Using the above definition, one finds a tremendous amount of corporate insanity out there. Management that expects next year to be better but doesn't know or is unwilling to change to get better results. This simple truth was shown in a 2003 study of 1900 professionals who help businesses in trouble.*

Table 4: Reasons For Decline

Too much Debt	28%
Inadequate Leadership	17%
Poor Planning	14%
Failure to Change	11%
Inexperienced Management	9%
Not Enough Revenue	8%

*** Source:** Buccino and Associates: Seton Hall University Stiffman School of Business, As reported in August 25, 2003, *Business Week*.

If one can detect the symptoms of decline early, one can more easily deal with it. Some of the more obvious signs being: declining sales relative to competitors, disappearing profit margins, and debt loads which continue to grow year after year. However, by the time the accountants figure out that the organisation is in trouble, it is often too late.

The Renewal Phase

Decline doesn't have to continue, however, external experts have focused on the importance of organisational development as a way of preventing decline or reducing its affects.

An interesting story from Aesop's *Fables* given below is worth remembering:

> "A horse rider took the utmost pains with his charger. As long as the war lasted, he looked upon him as his fellow-helper in all emergencies and fed him carefully with hay and corn. But when the war was over, he only allowed him chaff to eat and made him carry heavy loads of wood, subjecting him to much slavish drudgery and ill-treatment. War was again proclaimed, however, and when the trumpet summoned him to his

> standard, the soldier put on his charger its military trappings, and mounted, being clad in his heavy coat of mail. The horse fell down straightway under the weight, no longer equal to the burden, and said to his master, "You must now go to the war on foot, for you have transformed me from a horse into an ass; and how can you expect that I can again turn in a moment from an ass to a Horse?"

One way to reverse dry rot is through the use of training as a way of injecting new knowledge and skills. One can also put in place a rigorous program to change and transform organisation's culture.

Failure

As many as 80% of business failures occur due to factors within the executive's control. Even firms close to bankruptcy can overcome tremendous adversity to nurse themselves back to financial health. Lee Iacocca's turnaround of the Chrysler Corporation is one shining example.

In some cases, failure means being acquired and merged into a larger organisation. In other cases, it occurs when an organisation elects or is forced into bankruptcy. This does not signify the organisation ceases to exist since it can limp along for many years by going in and out of bankruptcy court.

1.7 VERTICAL AND HORIZONTAL ORGANISATION

The structure of an organisation is the manner in which various sub-units are arranged and inter-related as discussed at Section 1.3. The organisation structure provides guidelines on hierarchy, line of authority and relationships, linkage between different functions and coordination with environment. Structure in an organisation has three important components:

1) *Complexity,* referring to the degree to which activities within the organisation are differentiated. This differentiation has three dimensions —

   - *Horizontal* differentiation refers to the degree of differentiation between units based on the orientation of members, the nature of tasks they perform and their education and training,
   - *Vertical* differentiation is characterised by the number of hierarchical levels in the organisation, and
   - *Spatial* differentiation is the degree to which the location of the organisation's offices, facilities and personnel are geographically distributed.

2) *Formalisation* refers to the extent to which jobs within the organisation are specialised. The degree of formalisation can vary widely between and within organisations;

3) *Centralsation* refers to the degree to which decision-making is concentrated at one point in the organisation.

Now let us consider different types of organisation structures with merits and demerits in each of these types of structures.

The grouping of employees or departmentalisation in various types of organisation structures can be based on:

- By function or speciality

- By product line
- By customer / market segment
- By geographical area
- By work flow process
- Combination of the above.

Function Oriented (Vertical) Organisation Structures

A typical structure will look as shown in the Figure 2

The basic foundation of such organisations started from 20th century when there was lot of emphasis on specialisation during this industrial revolution era.

These basic underlying principals for such formation were:

- Specialization of labour
- Business processes were decomposed into narrower and narrower tasks
- Efforts were focused on improving the performance of those individual tasks
- Organisational units (functional departments) also reflected this narrow specialisation.

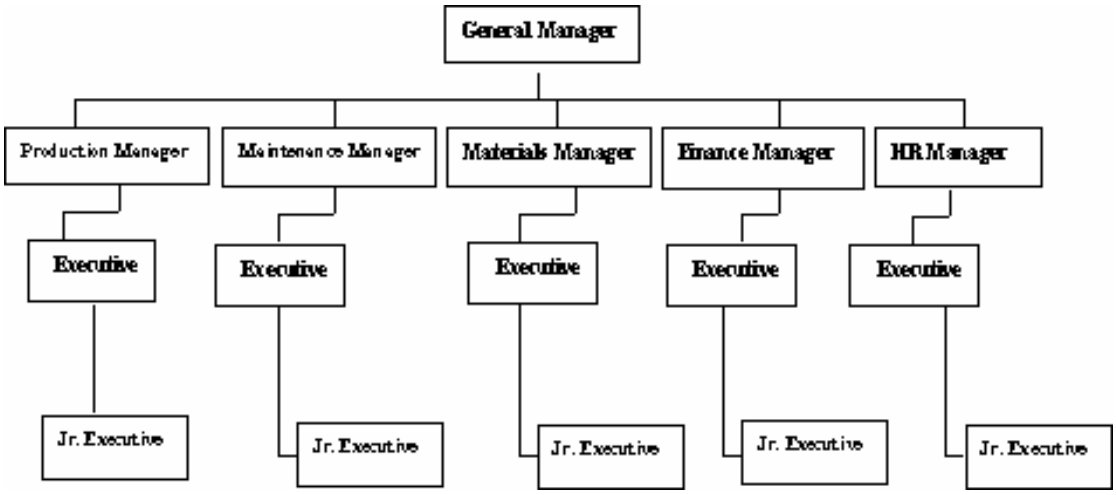

Figure 2: Function oriented organisation structure (Vertical Organisation)

Tasks – and the organisations based on them – formed the basic building blocks of 20th century enterprises.

The shortcomings in this type of structure were:

- Internal focus on functional goals rather than outward-looking concentration on winning customers and delivering value.
- Loss of important information as transactions travel up and down the multiple levels and across the functional departments.
- Fragmentation of performance objectives brought about by a multitude of distinct and fragmented goals.
- Added expense involved in coordinating the overly fragmented work and departments.
- Stifling of creativity and initiative of workers at lower levels.
- Slow responsiveness to changes in the external environment and to customer issues.
- Loss of sight of the totality of the business processes.

Competition and further industrialisation brought the concept of **Product Oriented Organisations,** which were comparatively better in many respects. A typical product oriented organisation structure is shown in *Figure 3*.

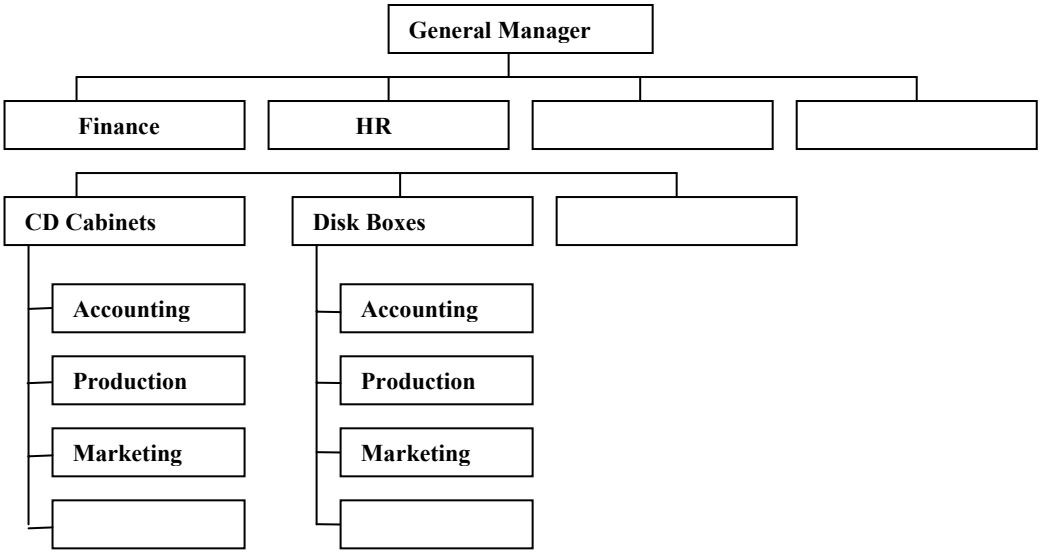

Figure 3: Product oriented organisation structure

Growth of the Organisation in vast areas made the management to operate the same organisation from multi locations. This brought forward the concept of **multi-locational / geographical based organisations**. A typical structure is shown in *Figure 4*.

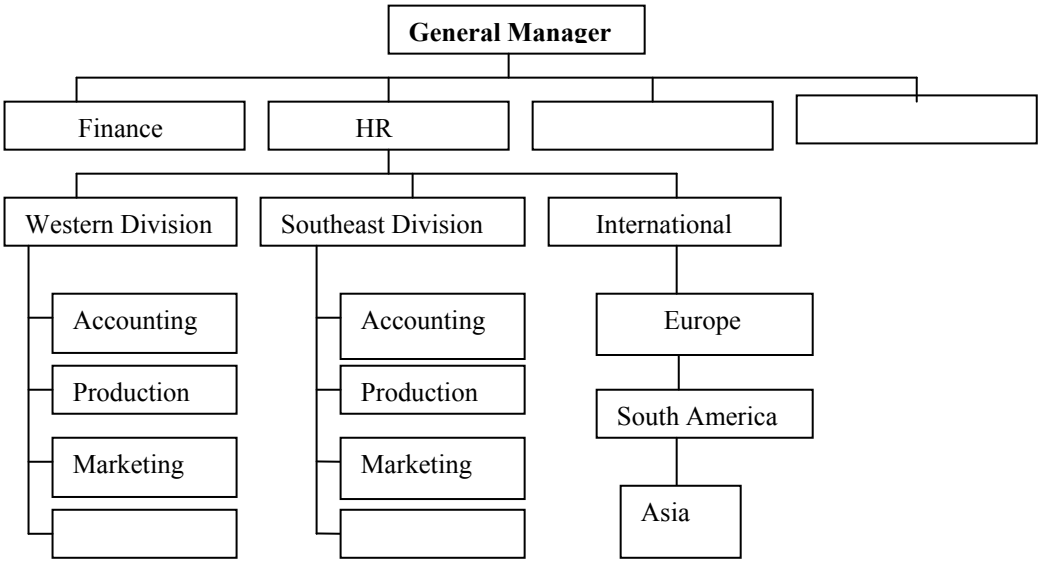

Figure 4: Multi location/geographical based organisation structure

Process Oriented (Horizontal) Organisation Structures:

Before we discuss Process oriented organisation structure, let us understand what is 'process' and how it is different from a 'task'.

- A task is a defined unit of work, usually performed by one person or small group.
- A process is a related group of tasks that together create an outcome of value to a customer.
- Only when all the tasks are performed together as a wholistic process the value is created.
- When rewards are based on task performance, the total process performance will usually be sub-optimal.

A Process oriented organisation has to be based on core processes. The core processes comprise of:

- End-to-end work, information and material flows.
- Extends across a business (and even beyond the business boundaries) and drives the achievement of fundamental performance objectives to an organisation's strategy.
- Usually not more than 4 to 10 in a typical organisation, which also depends on the business strategy of the organisation.

Typical major (Core) Business Process in an organisation are:

- **Order Acquisition Process** transforms a sales potential into a firm order in hand.
- **Order Fulfillment Process** transforms an order into delivered goods, a satisfied customer, and the paid bill.
- **Product Development Process** transforms a customer need and/or an advanced concept into a manufacturable design that satisfies the value proposition.
- **New Business Development Process** transforms technological and conceptual advancements into new businesses.
- **Customer Support Process** transforms customer concerns and needs into value-adding solutions.

Major processes are divided into sub-processes, which are then describable in terms of basic tasks or activities. Common Characteristics of Horizontally Structured Organisations are:

- Core processes group employees according to the sets and scope of multiple skills needed to meet performance objectives.
- Teams constitute the fundamental units of the organisation and are largely self-supervised.
- Process owners are responsible for leading and managing the entire core processes.
- The primary focus is external rather than internal, emphasizing the delivery.

A typical process based organisation structure is shown below in *Figure 5*.

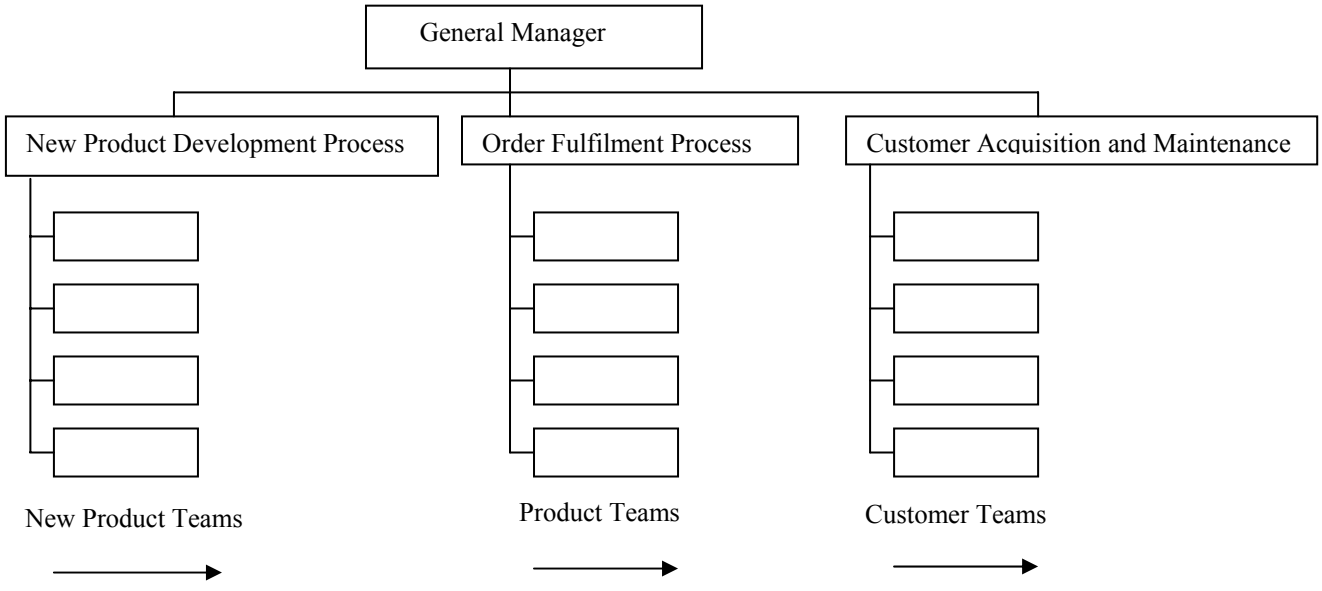

Figure 5: Process oriented organisation structure

Merits of an Process based Organisation Structure are:

- Eliminates the numerous handoffs that occur in functionally organised companies,
- Facilitates a tight alignment with what the customer wants,
- Highly compatible with the "lean paradigm",
- Fewer levels of hierarchy, reduced "overhead" effort,
- Facilitates agility, rapid re-configuration, as external environment changes,
- Performance measures and incentives/rewards can be tied more directly to tangible, measurable work progress,
- Enhances morale.

Vertical vs. Horizontal Organisations

Process-complete departments will have shorter cycle times for the jobs *only* if their managers have taken steps to reduce the cycle time by cultivating a collective sense of responsibility. Means for fostering collective responsibility are:

- Structure jobs with overlapping responsibilities,
- Arrange work areas so that people can see each other's work,
- Base incentives/rewards on group performance,
- Design procedures so that employees with different jobs are better able to collaborate.

Restructuring by process can lead to faster cycle times, greater customer satisfaction, and lower costs, but only if the organisation has a collaborative culture as stated above. But if companies are not willing to change their culture, they may be better off leaving functional departments intact.

Process oriented organisations are superior to *Functional organisations* for many situations, however, one size does not fit all in organisational focus. There are still many situations in which the classical vertical organisation is superior.

Check Your Progress 3

1) State True or False.

(i) Customer Support Process - transforms a sales potential into a firm order in hand. True ☐ False ☐

(ii) Product Development Process- transforms technological and conceptual advancements into new businesses. True ☐ False ☐

(iii) A Process oriented organisation has to be based on Core processes. True ☐ False ☐

(iv) Process based Organisation Structure facilitates a tight alignment with what the customer wants. True ☐ False ☐

(v) Process based Organisation Structure limits Enhancing of morale. True ☐ False ☐

2) Answer the following:

(i) What are the five most acceptable stages during organisational life cycle?

……

……

……

(ii) What are the shortcomings in the Function Oriented (Vertical) type of organisational structure?

……

……

……

1.8 SUMMARY

This completes the discussion regarding organisations overview, the fundamentals and types of organisations as well as diversities and similarities in various organisations. These concepts are essential to be understood and addressed for information system design.

With the increase in competition and globalisation each organisation desires to carry out more and more of its functionality with use of Information technology to enhance productivity. Therefore, students are advised to read supplementary material covering case studies.

1.9 SOLUTIONS/ANSWERS

Check Your Progress 1

1) (i) False, (ii) False, (iii) True, (iv) False, (v) True

2) (i) At Macro level organisations have three types as indicated below along with their distinct features:

- **Extraction organisations:** These organisations produce goods by extracting them from the earth.
- **Manufacturing organisations:** These organisations produce goods by conversion or by processing of one type of goods designated as raw materials into other type of goods designated as finished goods.
- **Service organisations** do not produce any tangible goods but produce services only. Services are intangible items having no shape or colour.

(ii) The six key elements required for designing an organisational structure are:

- Work Specialisation
- Departmentalisation
- Chain of command
- Span of control
- Centralisation and decentralisation
- Formalisation

Check Your Progress 2

1) (i) False, (ii) False, (iii) False, (iv)True, (v) True.

2) (i) Four common features of organisations are:

- Formal Structure,
- Principal of Division of labour,
- Standard Operating Procedures, and
- Decision Making Process.

And five unique characteristics of organisation are:

- Organisational Type,
- Environment,
- Size of the Organisation,

- Locations Involved, and
- Business Processes.

(ii) Three examples (names) of each of the following functional organizations are:

***Business*:** Reliance Infotech, Maruti Udyog Ltd., Bharat Petroleum.

***Bureaucracy*:** Government of Madhya Pradesh, Delhi Public School and Supreme Court of India.

***Charity*:** Ford Foundation, Rajiv Foundation and Gandhi Memorial trust.

Mutual Cooperation: Unit Trust of India, Indian Farmers Fertilizers Corporation (IFFCO), and Industrial Cooperative Bank.

***International Cooperation*:** United Nations, World Health Organisation, and World Trade Organisation.

Check Your Progress 3

1) (i) False, (ii) False, (iii) True, (iv) True (v) False

2) (i) The most acceptable five stages during organisational life cycle are:

(a) Startup / Birth
(b) Growth.
(c) Decline. When in decline, an organisation will either undergo,
(d) Renewal or
(e) Death / bankruptcy.

(ii) The shortcomings in the Function Oriented (Vertical) type of organisational structure are:

- Internal focus on functional goals rather than outward-looking concentration on winning customers and delivering value;
- Loss of important information as transactions travel up and down the multiple levels and across the functional departments;
- Fragmentation of performance objectives brought about by a multitude of distinct and fragmented goals;
- Added expense involved in coordinating the overly fragmented work and departments;
- Stifling of creativity and initiative of workers at lower levels;
- Slow responsiveness to changes in the external environment and to customer issues;
- Loss of sight of the totality of the business processes.

1.10 FURTHER READINGS/REFERENCES

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UNIT 2 MANAGEMENT FUNCTIONS AND BUSINESS PROCESSES

Structure **Page No.**

2.0 INTRODUCTION

For successful and efficient operation of an organisation appropriate management is required is a well known fact. In the previous unit, you have learnt about organisations, their functions, structure and objectives and also learnt the commonalities of the organisations as well as how diverse requirements for their management can be there. In this unit, we will discuss how this requirement is met by understanding management functions, their hierarchical requirements and the business functionality requirements.

In this unit, we will also discuss how information system requirements can be worked out to assist and help the management in discharging their various roles for successful operation of the organisation.

2.1 OBJECTIVES

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

- understand the management functions at various levels of the management;
- define the business processes;
- work out the information system requirements of an organisation, and
- will become familiar with the latest tools and methods for working out the information system requirements.

2.2 MANAGEMENT FUNCTIONS AND LEVELS

"*Management*" (from Old French *ménagement* “the art of conducting, directing”, from Latin *manu agere* “to lead by the hand”) characterises the process of leading and directing all or part of an organisation, often a business, through the deployment and manipulation of resources (human, financial, material, intellectual or intangible). Early

twentieth-century management writer Mary Parker Follett defined management as "the art of getting things done through people."

One can also think of management functionally, as the action of measuring a quantity on a regular basis and of adjusting some initial plan, and as the actions taken to reach one's intended goal. This applies even in situations where planning does not take place. From this perspective, there are five management functions: Planning, Organising, Leading, Coordinating, and Controlling.

Management

Management is also called "Business Administration", and schools that teach management are usually called "Business Schools". The term "management" may also be used to describe the slate of managers of an organisation, for example, of a corporation. A governing body is a term used to describe a group formed to manage an organisation, such as a sports league.

In for-profit work, the primary function of management is to satisfy a range of stakeholders. This typically involves making a profit (for the shareholders), creating valued products at a reasonable cost (for customers), and providing rewarding employment opportunities (for employees). In nonprofit work it is also important to keep the faith of donors. In most models of management, shareholders vote for the board of directors, and that board then hires senior management. Some organisations are experimenting with other methods (such as employee voting models) of selecting or reviewing managers/senior managers but this is very rare.

In the public sector of countries constituted as representative democracies, politicians are elected to public office. They hire many managers and administrators, and in some countries like the United States, a great many people lose jobs when a new President comes into office. 2500 people serve "at the pleasure of the President" including all the top US government executives.

Public, private and voluntary sectors place different demands on managers, but all must retain the faith of those who select them (if they wish to retain their jobs), retain the faith of those people that fund the organisation, and retain the faith of those who work for the organisation. If they fail to convince employees that they are better off staying than leaving, the organisation will be forced into a downward spiral of hiring, training, firing, and recruiting.

Management also has a responsibility to innovate and improve the functioning of the organisation.

In all but the smallest organisations, achieving these objectives involves a division of management and labour. People specialise in a limited range of functions so as to more quickly gain competence and expertise. Even in employee managed workplaces such as a Wobbly Shop, where managers are elected, or where latitude of action is sharply restricted by collective bargaining or unions, managers still take on roughly the same functions and job descriptions as in a more traditional command hierarchy.

As has been said above management has been defined by various scholars, among them widely accepted definition by Koontz is '*Management is the art of getting things done through and with the people in formally organised groups*.'

Management Functions

The five basic *Functions*, which a manager has to perform as per classical model of management, which has been accepted since 1920's and is still popular, by early authors like Henry Fayol are:

- Planning,
- Organising,
- Coordinating,
- Directing, and
- Controlling.

To get an insight into Management let us understand these functions one by one.

Planning

Planning is a process of forecasting the future in advance. From where we are it leads to where we want to be. Planning requires rigorous analysis of input, output and costs. Let us suppose we want to establish a new factory or in a factory a new product. Planning for this will require collection of basic information such as expected sales, production capacity required, types of machinery, capital, foreign exchange requirement, organisation structure required to handle various jobs etc. Since planning is to chart the future course of action, it should answer the following questions and may be a few more:

- What to do?
- When to do?
- Who is to do?
- How is it to be done?
- Where is to be done?
- Why is to be done?

In an organisation for facilitating this planning process, goals are set, objectives are defined, policies, rules and procedures are laid down, programs are worked out, and budgets, strategies, and schedules are finalised.

Organising

Organising it the process of identifying the entire job, dividing the job into convenient subjects / tasks, allocating sub-jobs to persons or group of persons and delegating authority to each so that the job is carried out as planned.

Coordinating

Coordination is the process of putting the right person or group of persons at the right job. This function involves activities like defining the requirements with regard to the people for the job to be done, selecting suitable persons, training and developing them so that they can perform the desired job(s).

Directing

Henri Fayol has identified the function of Directing with command. However, modern management experts are of the view that directing includes:

- Communication,
- Motivation, and

- Leadership.

Directing is important because in order to achieve pre-determined goals and objectives people manning the organisation have to be guided, motivated and led by the manager.

Controlling

Controlling is the Function to ensure that things are going, as they should be. Actual performance must be compared with previously set goals. If there are any significant deviations, management must take the corrective steps to bring the things on track. Thus controlling is the process that involves:

- Fixing standards for measuring work performance,
- Measurement of actual performance,
- Comparing actual with standards and finding out deviations, if any, and
- Taking corrective actions.

To perform these functions management has to take a variety of decisions. In other words, *decision-making* is a fundamental pre-requisite for each of the processes talked above. As per Peter Drucker 'Whatever a manager does, he does it through decision making'. Thus decision-making is the Essence of Management.

To further understand functioning of a business organisation, let us briefly discuss the Levels of Management.

Levels of Management

Managers are organisational members who are responsible for the work performance of other organisational members. Managers have formal authority to use organisational resources and to make decisions. In organisations, there are typically three levels of management: top-level, middle-level, and first-level or operational level as shown in *Figure 1*. These three main levels of managers form a hierarchy, in which they are ranked in order of importance. In most organisations, the number of managers at each level is such that the hierarchy resembles a pyramid, with many more first-level managers, fewer middle managers, and the fewest managers at the top level. Each of these management levels is described below in terms of their possible job titles and their primary responsibilities and the paths taken to hold these positions. Additionally, there are differences across the management levels as to what types of management tasks each does and the roles that they take in their jobs. Finally, there are a number of changes that are occurring in many organisations that are changing the management hierarchies in them, such as the increasing use of teams, the prevalence of outsourcing, and the flattening of organisational structures.

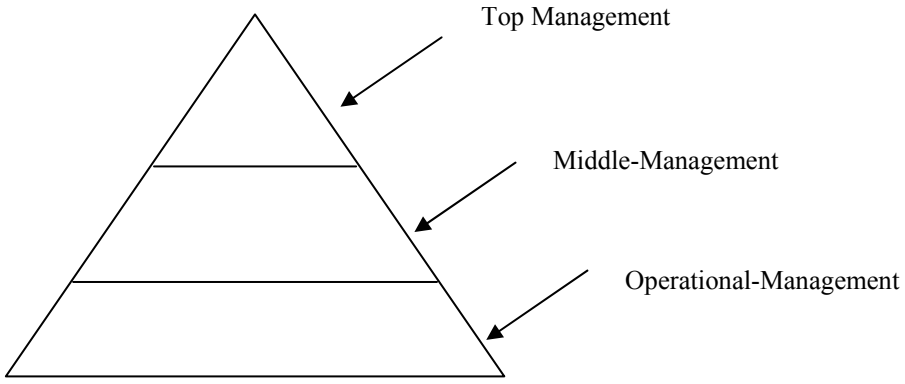

Figure 1: Basic levels of management

Top-Level Managers

Top-level managers, or top managers, are also called senior management or executives. These individuals are at the top one or two levels in an organisation, and hold titles such as: Chief Executive Officer (CEO), Chief Financial Officer (CFO), Chief Operational Officer (COO), Chief Information Officer (CIO), Chairperson of the Board, President, Vice president, Corporate head.

Often, a set of these managers will constitute the top management team, which is composed of the CEO, the COO, and other department heads. Top-level managers make decisions affecting the entirety of the firm. Top managers do not direct the day-to-day activities of the firm; rather, they set goals for the organisation and direct the company to achieve them. Top managers are ultimately responsible for the performance of the organisation, and often, these managers have very visible jobs.

Top managers in most organisations have a great deal of managerial experience and have moved up through the ranks of management within the company or in another firm. An exception to this is a top manager who is also an entrepreneur; such an individual may start a small company and manage it until it grows enough to support several levels of management. Many top managers possess an advanced degree, such as a Masters in Business Administration, but such a degree is not required.

Some CEOs are hired in from other top management positions in other companies. Conversely, they may be promoted from within and groomed for top management with management development activities, coaching, and mentoring. They may be tagged for promotion through succession planning, which identifies high potential managers.

Middle-Level Managers

Middle-level managers, or middle managers, are those in the levels below top managers. Middle managers' job titles include: General Manager, Plant manager, Regional manager, and Divisional Manager.

Middle-level managers are responsible for carrying out the goals set by top management. They do so by setting goals for their departments and other business units. Middle managers can motivate and assist first-line managers to achieve business objectives. Middle managers may also communicate upward, by offering suggestions and feedback to top managers. Because middle managers are more involved in the day-to-day workings of a company, they may provide valuable information to top managers to help improve the organisation's bottom line.

Jobs in middle management vary widely in terms of responsibility and salary. Depending on the size of the company and the number of middle-level managers in the firm, middle managers may supervise only a small group of employees, or they may manage very large groups, such as an entire business location. Middle managers may be employees who were promoted from first-level manager positions within the organisation, or they may have been hired from outside the firm. Some middle managers may have aspirations to hold positions in top management in the future.

First-Level / Operational Level Managers

First-level managers are also called first-line managers or supervisors. These managers have job titles such as: Office manager, Shift Supervisor, Department Manager, Foreperson, Crew Leader, Store Manager.

First-line managers are responsible for the daily management of line workers — the employees who actually produce the product or offer the service. There are first-line

managers in every work unit in the organisation. Although first-level managers typically do not set goals for the organisation, they have a very strong influence on the company. These are the managers that most employees interact with on a daily basis, and if the managers perform poorly, employees may also perform poorly, may lack motivation, or may leave the company.
In the past, most first-line managers were employees who were promoted from line positions (such as production or clerical jobs). Rarely did these employees have formal education beyond the high school level. However, many first-line managers are now graduates of a trade school, or have a two-year associates or a four-year bachelor's degree from college.

Knowledge Workers

Number of organisations in today's environment; also have another level for Knowledge Workers. Primarily, the knowledge workers are above the operational managers in the organisations. These workers deal more with Research and Development jobs and also with analysing data for Knowledge Extraction.

The interaction amongst the three levels of the management can be summarized as per Jerome Kanter (1996). The Top Management, which is also known as Strategic level, establishes the policies, plans and objectives of the company as well as general budget framework of the company under which the various departments will operate. These Factors passed down to middle management, where these are translated into specific revenue, cost and profit goals. These are reviewed, analysed and modified in accordance with the overall plan and policies, until agreement is reached. Middle management then issues the specific schedules and measurement yardsticks to the operating management. The latter level has the job of producing, and / or selling of the goods and services required to meet the revenue and profit goals, which in turn will enable the company to reach its overall plans and objectives. This interaction has been shown in the following *Figure 2*.

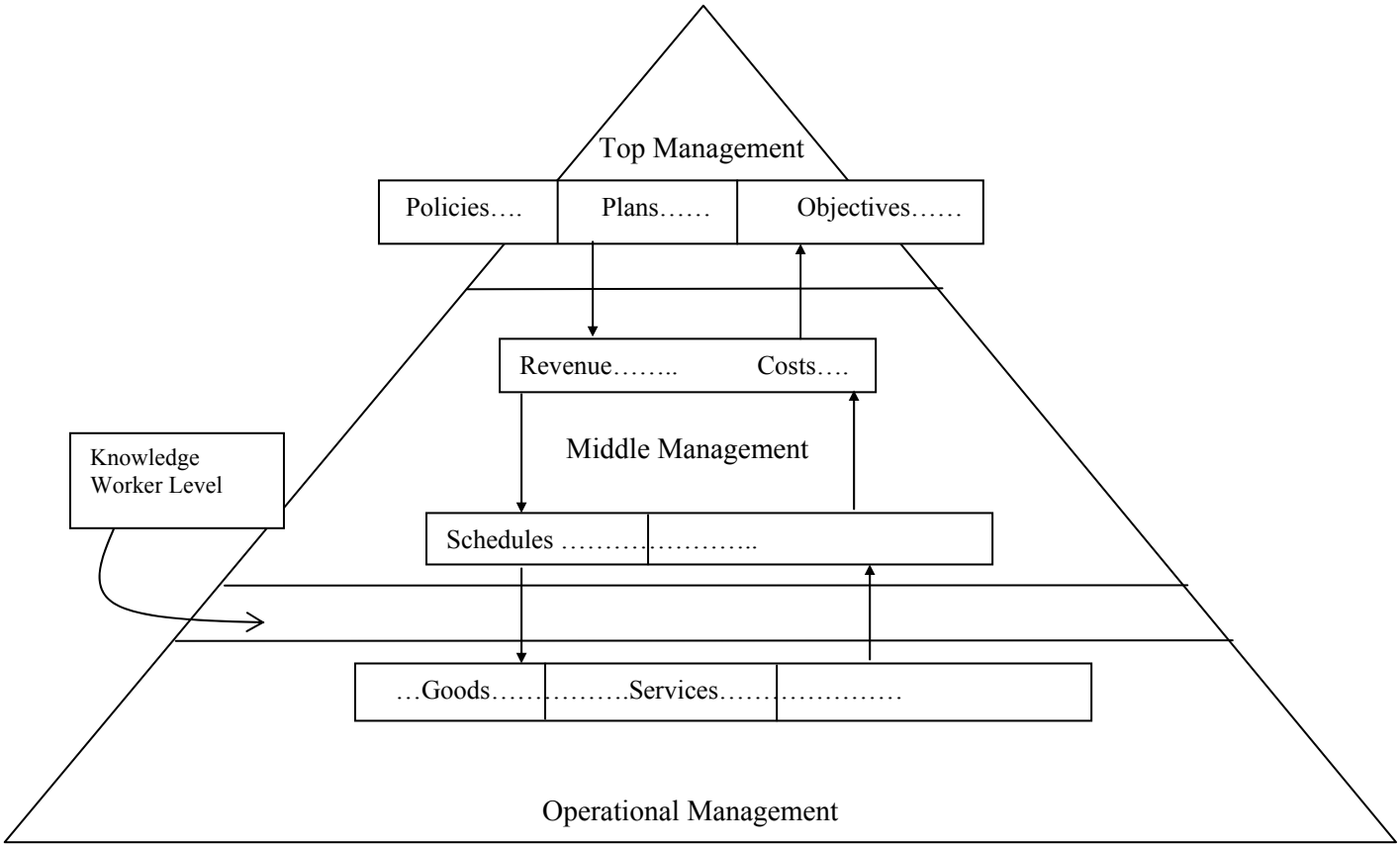

Figure 2: Management roles at various levels

2.3 BUSINESS FUNCTIONS AND PROCESSES

Business Functions

Business activities are grouped around functions such as production, finance and personnel, etc. resulting in department or an area of the business organisation. Each of these functional areas is interdependent and is part of the organisational system. A typical set of functions in a manufacturing organisation includes

1) Sales and marketing,
2) Manufacturing and production,
3) Finance and accounts,
4) Human Resource, and
5) Materials Management

Information Technology now is an integral part of all business functions. Some of the main activities for each functional area have been shown in the *Figure 3*.

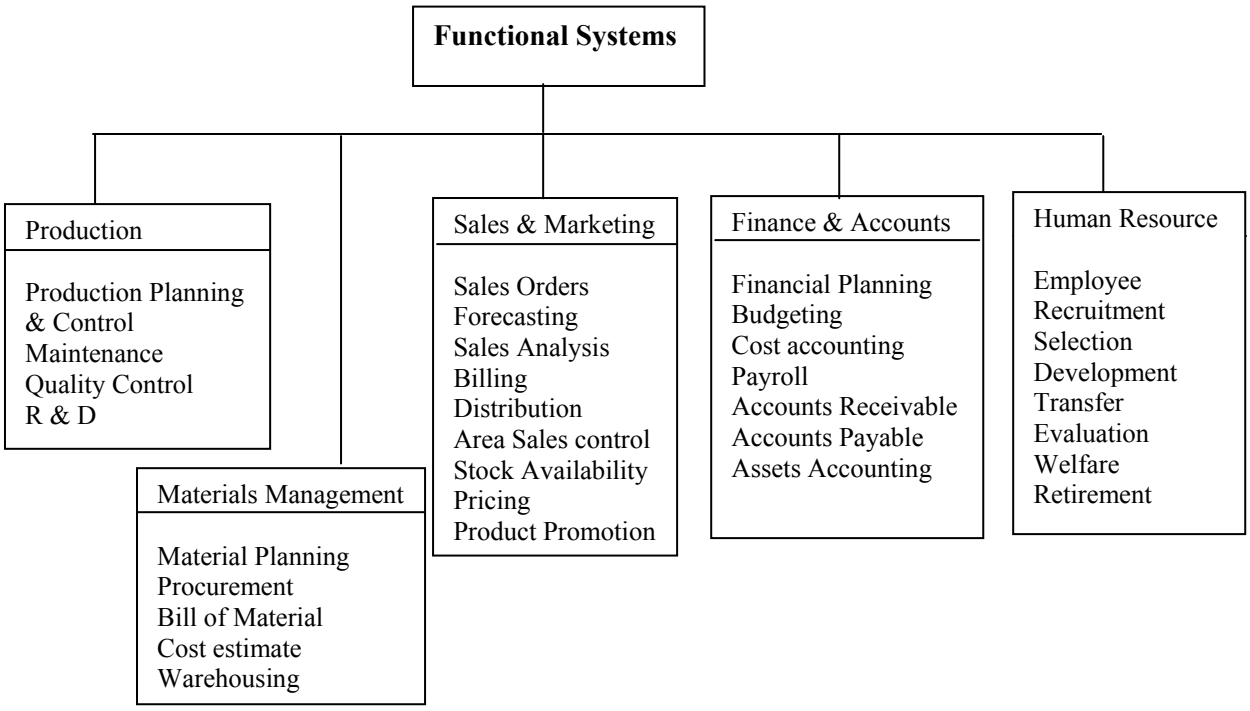

Figure 3: Main Activities of Functional Areas

2.3.1 Sales and Marketing

The sales and marketing function is responsible for selling the organisation's product or service. Marketing is concerned with identifying the customers for the firm's products or services, determining what they need or want, planning and developing products and services to meet their needs, and advertising and promoting these products and services. Sales is concerned with contacting customers, selling the products and services, taking orders, and following up on sales. Sales and marketing information systems are required to support these activities:

Table 1: Examples of Sales and Marketing Information Systems

System	Description	Organisational Level
Order processing	Enter, process, and track orders	Operational
Market analysis	Identify customers and markets using data on demographics, markets, consumer behavior, and trends	Knowledge
Pricing analysis	Determine prices for products and services	Management
Sales trend forecasting	Prepare 5-year sales forecasts Strategic	Strategic

Information systems are used in sales and marketing function in a number of ways as shown in *Table 1* above. At the strategic level, sales and marketing systems monitor trends affecting new products and sales opportunities, support planning for new products and services, and monitor the performance of competitors. At the management level, sales and marketing systems support market research, advertising and promotional campaigns, and pricing decisions. They analyze sales performance and the performance of the sales staff. Knowledge-level sales and marketing systems support marketing analysis workstations. At the operational level, sales and marketing systems assist in locating and contacting prospective customers, tracking sales, processing orders, and providing customer service support.

Figure 4 shows the output of a typical sales information system at the management level. The system consolidates data about each item sold (such as the product code, product description, and price) for further management analysis. Company managers examine these sales data to monitor sales activity and buying trends. The Window on Management describes some typical sales and marketing systems that might be found in a small business.

PRODUCT CODE	PRODUCT DESCRIPTION	SALES REGION	ACTUAL SALES	PLANNED	ACTUAL VS PLANNED
4469	Carpet Cleaner	Northeast	4.066.700	4.800.000	0.85
		South	3.778.112	3.750.000	1.01
		Midwest	4.867.001	4.600.000	1.06
		West	4.003.440	4.400.000	0.91
	TOTAL		16,715,253	17.550.000	0.95
5674	Room Freshener	Northeast	3.676.700	3.900.000	0.94
		South	5.608.112	4.700.000	1.19
		Midwest	4.711.001	4.200.000	1.12
		West	4.563.440	4.900.000	0.93
			18.559.253	17.700.000	1.05

Figure 4: Sales information system

The concept of marketing has undergone a sea change and today the traditional concept of marketing does not hold true. Whereas traditional practices of marketing start with production and consider marketing to be of use in selling and promotion to attain sales at a profit, modern marketing focuses its attention on customers / buyers. It gets profit through the creation of the buyer's satisfaction and further seeks to achieve it through an integrated, corporate wide set of marketing activities. These two views have been shown in *Figure 5*.

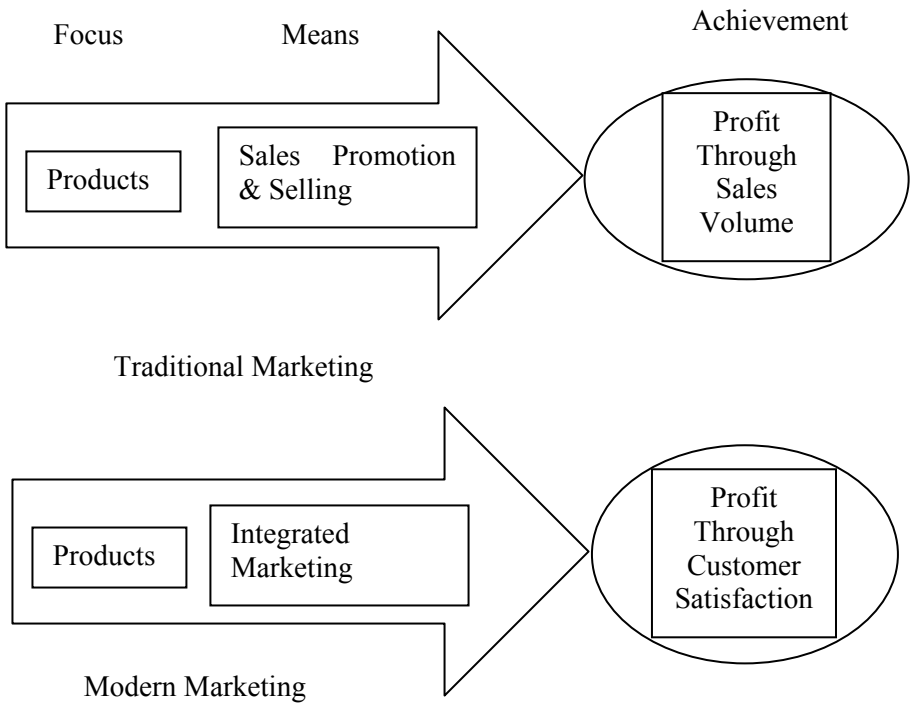

Figure 5: Traditional vs. modem marketing

Modern marketing does not remain confined to activities like advertising, selling and distribution but it also involves interaction of several other business activities with the objective of satisfying customers' needs and aspirations. The marketing activities start with exploring and understanding customers' need even before the product is produced, so that the product is designed keeping customers needs in mind. In case of traditional marketing, the product is produced and the product is pushed to the market with aggressive selling and promotional efforts.

Some of the important functions covered in the modern marketing processes as are:

Identification of the potential market: The potential market and customers are located with the target questions like:

- Where are the potential buyers located?
- When do they buy?
- How much they buy?
- How frequently they buy?
- What are the preferences of the customer for the intended product?

Identification of purchase motivation factors: Assessment is made regarding social, economic and psychological factors influencing purchases by the potential customers.

The distribution and transportation factors: are reviewed to optimization cost by integrating movement and warehousing.

Product design adjustment factors: Based on the preferred products in the market, product design is reviewed.

Communication factors: Advertising, personal selling, sales promotion, publicity and packaging are reviewed to enable most optimum communication to the customer.

Transaction functions: Order booking, invoicing, billing, credit realisation etc. are reviewed to make them more customer friendly.

Post-transaction factors: After sales service is given due attention to ensure repeated purchases by the customers.

The marketing information system, which can provide assistance / support to correct decision is very important for success of all above factors.

2.3.2 Manufacturing and Production

The manufacturing and production function is responsible for actually producing the firm's goods and services. Manufacturing and production systems deal with the planning, development, and maintenance of production facilities; the establishment of production goals; the acquisition, storage, and availability of production materials; and the scheduling of equipment, facilities, materials, and labour required to produce the finished products. Manufacturing and production information systems support these activities.

Table 2 shows some typical manufacturing and production information systems arranged by organisational level. Strategic-level manufacturing systems deal with the firm long-term manufacturing goals, such as where to locate new plants or whether to invest in new manufacturing technology. At the management level, manufacturing and production systems analyse and monitor manufacturing and production costs and resources. Knowledge manufacturing and production systems create and distribute design knowledge or expertise to drive the production process, and operational manufacturing and production systems deal with the status of production tasks.

Table 2: Examples of Manufacturing and Production Information Systems

System	Description	Organisational Level
Machine control	Control the actions of machines and equipment	Operational
Computer-aided design (CAD)	Design new products using the computer	Knowledge
Production planning	Decide when and how many products should be produced	Management
Facilities location	Decide where to locate new production facilities	Strategic

Quality Control, Environmental Control and Safety are the other factors, which are required to be controlled as part of present day Production Functions. More and more organisations are going in for International Standards (ISO 9000 for Quality, ISO14000 for Environment). These standards require control of raw material, equipment maintenance and performance in an integrated manner, which is possible only through good information system and analysis.

2.3.3 Finance and Accounts

The finance function is responsible for managing the firm's financial assets, such as cash, stocks, bonds, and other investments, in order to maximize the return on these financial assets. The finance function is also in charge of managing the capitalisation of the firm (finding new financial assets in stocks, bonds, or other forms of debt). In order to determine whether the firm is getting the best return on its investments, the finance function must obtain a considerable amount of information from sources external to the firm.

The accounting function is responsible for maintaining and managing the firm's financial records — receipts, disbursements, depreciation, payroll — to account for the flow of funds in a firm. Finance and accounting share related problems — how to keep track of a firm's financial assets and fund flows. They provide answers to questions such as: What is the current inventory of financial assets? What records exist for disbursements, receipts, payroll, and other fund flows?

Table 3: Examples of Finance and Accounting Information Systems

System	Description	Organisational Level
Accounts receivable	Track money owed the firm	Operational
Portfolio analysis	Design the firm's portfolio of investments	Knowledge
Budgeting	Prepare short-term budgets	Management
Profit planning	Plan long-term profits	Strategic

Table 3 shows some of the typical finance and accounting information systems found in large organisations. Strategic-level systems for the finance and accounting function establish long-term investment goals for the firm and provide long-range forecasts of the firm's financial performance. At the management level, information systems help managers oversee and control the firm's financial resources. Knowledge systems support finance and accounting by providing analytical tools and workstations for designing the right mix of investments to maximize returns for the firm. Operational systems in finance and accounting track the flow of funds in the firm through transactions such as paychecks, payments to vendors, securities reports, and receipts.

2.3.4 Human Resource

The human resources function is responsible for attracting, developing, and maintaining the firm's workforce. Human resources information systems support activities such as identifying potential employees, maintaining complete records on existing employees, and creating programs to develop employees' talents and skills.

Strategic-level human resources systems identify the support requirements (skills, educational level, types of positions, number of positions, and cost) for meeting the firm's long-term business plans. At the management level, human resources systems help managers monitor and analyse the recruitment, allocation, and compensation of employees. Knowledge systems for human resources support analysis activities related to job design, training, and the modelling of employee career paths and reporting relationships. Human resources operational systems track the recruitment and placement of the firm's employees (see *Table 4*).

Figure 6 illustrates a typical human resources record keeping. It maintains basic employee data, such as the employee's name, age, sex, marital status, address, educational background, salary, job title, date of hire, and date of Training. The system can produce a variety of reports, such as lists of newly hired employees, Areas in which employees have been trained etc. employees are classified by job type or educational level, or job performance evaluations. Such systems are typically designed to provide data that can satisfy income tax, Provident fund and other statutory requirements and record keeping requirements for Equal Employment Opportunity (EEO) and other purposes.

Table 4: Examples of Human Resources Information Systems

System	Description	Organisational Level
Staffing, Training and development	Track recruitment, employee training, skills, and performance appraisals	Operational
Career plan	Design career paths for employees	Knowledge
Compensation analysis	Monitor the range and distribution of employee wages, salaries, and benefits	Management
Human resources planning	Plan the long-term labour force needs of the organisation and succession planning	Strategic

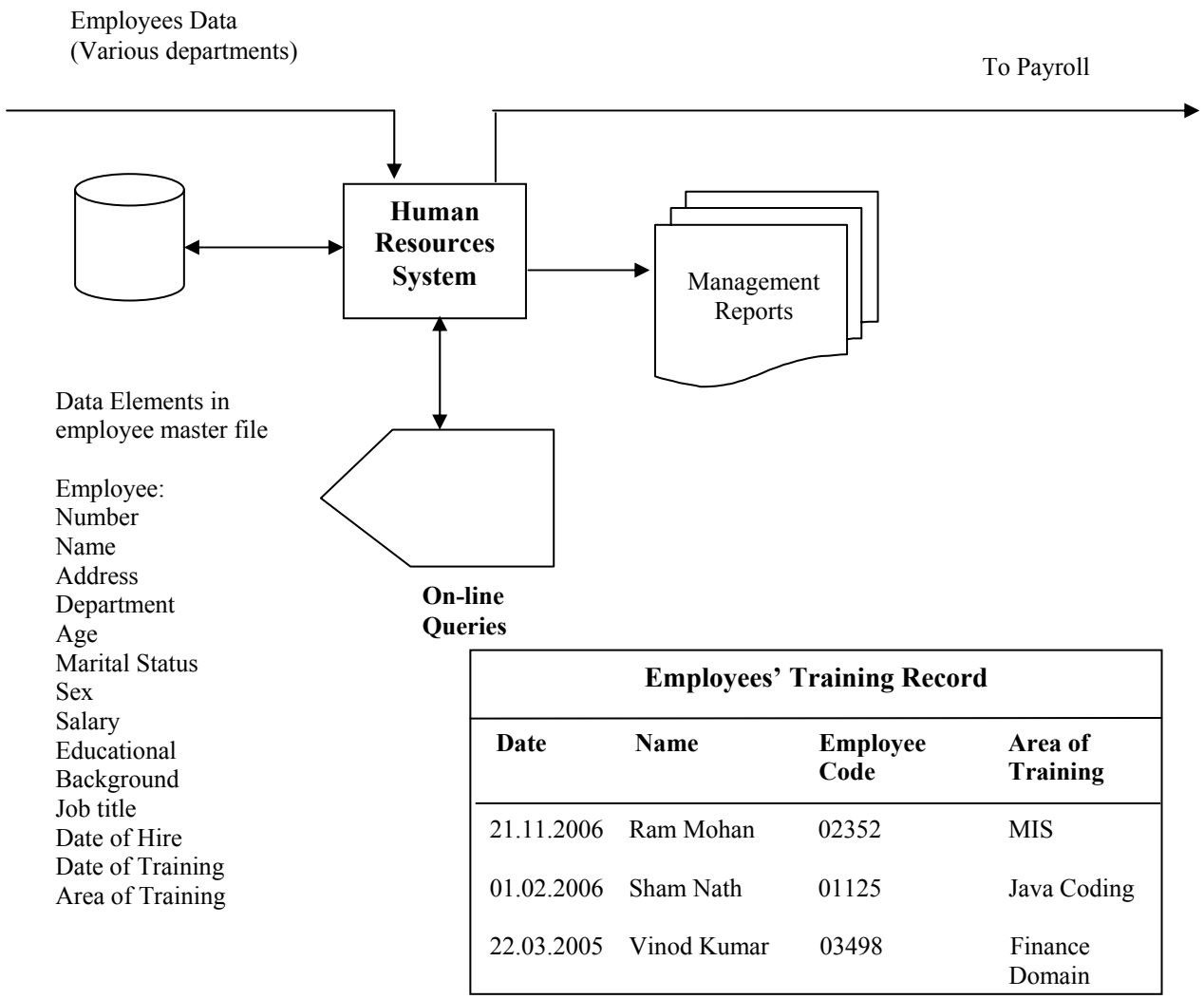

Figure 6: An employee record keeping system. This System Maintains Data on the Firm's Employees to Support the Human Resources Function

2.3.5 Materials Management

The materials management function is responsible for procurement of raw materials and other items like plant and equipment and spare parts etc. For typical manufacturing companies about 50-70 % of the total cost is on account of materials. Therefore, for continued successful operation of any organisation in the competitive environment, good materials management and information system is very important. Information system is required because materials management is more dependent on flow of information. Strategic level system for materials management identifies long

term sourcing of raw materials and other supplies. The management system provides for the selection of the vendors meeting the quality and cost requirements. Knowledge system provides the trends on supplies. The operation system keeps track of the supplies with the vendors as shown in *Table 5.*

Table 5: Examples of Materials Management Information Systems

System	Description	Organisational Level
Inventory system	Track receipt of materials with the vendors and stock position in store.	Operational
Trends	Design vendor evaluation and Inventory control system.	Knowledge
Vendors selection	Monitor the vendors performance and Inventory control for cost optimisation.	Management
Long term sourcing of materials	Plan long-term sources for raw materials, plant and equipment. Procurement policy review.	Strategic

Inventory system is essential for most of the manufacturing and production systems. As illustrated in *Figure 7*, data about each item in inventory, such as the number of units depleted because of a shipment or purchase or the number of units replenished by reordering or returns, are either scanned or keyed into the system. The inventory master file contains basic data about each item, including the unique identification code for each item, the description of the item, the number of units on hand, the number of units on order, and the reorder point (the number of units in inventory that triggers a decision to reorder to prevent a stock out). Companies can estimate the number of items to reorder or they can use a formula for calculating the least expensive quantity to reorder called the *economic order quantity.* The system produces reports such as the number of each item available in inventory, the number of units of each item to reorder, or items in inventory that must be replenished.

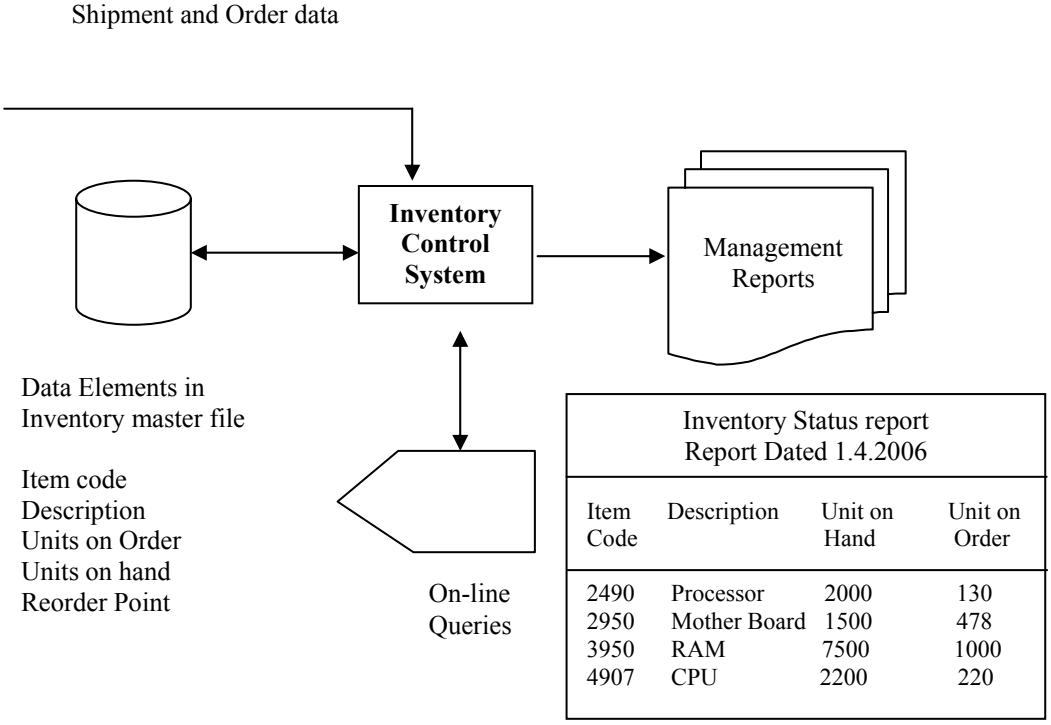

Figure 7: Overview of an inventory system. This System Provides Information about the Number of Items Available in Inventory to Support Manufacturing and Production Activities

Business Processes

A *Business Process* is best defined as any function within an organisation that enables the organisation to successfully deliver its products and services. A simple analogy would be to look at an organisation as a wheel and the individual Business Processes are the spokes to the wheel. Having just one or two spokes loose can make a wheel out-of-balance. The longer a wheel runs out of balance the more damaging the effect to the organisation. When the wheel on a cart becomes so unstable that its primary function fails, you would simply replace the wheel. Obviously, an organisation cannot simply replace itself... but your customer can and will replace the wheel (you the Supplier) if you fail to perform to the customers' needs and expectations. Obviously, this is a very simplistic and extreme analogy about the operation of an organisation. But, when you step back and look at the products and services you purchase yourself, it actually becomes a little more understandable. You wouldn't maintain a business relationship with a supplier if the suppliers' own internal Business Processes prevented the supplier from performing its best. You would probably go to another supplier.

A *Business processes* can be defined as a unique manner in which work is organised, coordinated, and focused to produce a valuable product or service. On the one hand, business processes are concrete workflows of material, information, and knowledge– sets of activities. On the other hand, business processes represent unique ways in which organisations coordinate work, information, and knowledge, and the ways in which management chooses to coordinate work. *Table 6* describes typical business processes for each of the functional areas.

Table 6: Functional Area and Business Processes

Sl. No.	Functional Area	Typical Business Process
1	Sales / Marketing	Identifying customers Familiarising customers with the product Selling the product
2	Manufacturing / Production	Assembling the product Quality checking Making bills of materials.
3	Finance / Accounts	Paying creditors Managing cash Creating financial statements
4	Human Resource	Hiring employees Working out compensation plan Employee performance evaluation.
5	Other types- Materials	Issuing tender enquiries Awarding purchase orders Carrying out inventory control

Although each of the major business functions has its own set of business processes, many other business processes are cross-functional, transcending the boundaries between sales, marketing, manufacturing, and research and development. These cross-functional processes cut across the traditional organisational structure, grouping employees from different functional specialties to complete a piece of work. For example, the order fulfilment process at many companies requires cooperation among the sales function (receiving the order, entering the order), the accounting function (credit checking and billing for the order), and the manufacturing function (assembling and shipping the order) as shown in *Figure 8*.

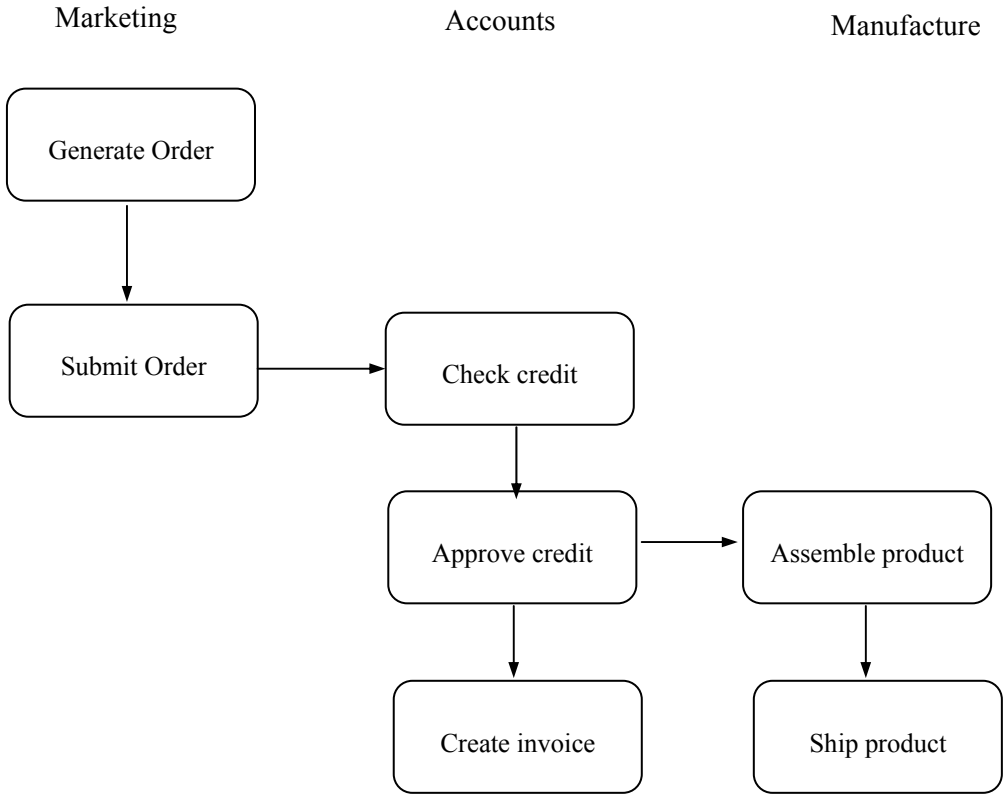

Figure 8: Cross functional business process

Organisational structure throughout the many diverse industries varies, but for the most part, all organisations perform similar Business Processes. Whether you are from a large or small corporation, government agency, or a non-profit association, to a large extent, you share common Business Processes with other industries. The Business Process of Human Resources for one industry can be very similar to another. In fact, the Human Resource Business Processes may even be a Critical Success Factor for some of the industries.

Today ready-made solutions for Common Business Processes are available, which require little bit of customisation for using in variety of organisations. Some of business processes for which such packages are available are given in the *Table 7*.

Table 7: Common Business Processes

Activity based costing	Employee - benefits	Inventory management	Project management
Accounting	Employee - communication	Internship	Public relations
Acquisitions	Employee - compensation	ISO	Purchasing
Assembly	Employee - development	Knowledge management	Quality
Asset management	Employee – evaluation	Leadership	Quality assurance
Balanced scorecard	Employee - incentive programs	Logistics	Quality improvement
Benchmarking	Employee – recognition	Loss management	Records management
Billing budget	Employee- recruiting	Maintenance management	Recycling
Calibration	Employee - retention / turnover	Manufacturing	Reengineering
Call centres	Employee - satisfaction	Marketing	Refurbishing

Charity	Employee - suggestions	Material management	Regulations
Complaint handling	Employee - training	Mentoring	Repair
Configuration management	Engineering	Mergers	Reliability
Contracting	Environment	Operations	Research & development
Cost controls	External communications	Order fulfilment	Restoration
Cost measuring	Facility management	Order processing	Risk management
Creativity	Failure analysis	Outsourcing	Sales
Credit management	Failure measuring	Payroll	Security
Customer - requirements	Failure monitoring	Performance improvement	Self directed teams
Customer - satisfaction	Finance	Performance measurement	Service
Customer – service	Fleet management	Planning	Service delivery
Customer - training	Franchising	Policy	Stewardship
Debt collection	Freight	Process improvement	Staffing
Delivery	Health & safety	Process management	Strategic planning
Direct mail	Help desks	Procurement	Supplier management
Disaster recovery	Human resources	Product delivery	Telecommuting
Distribution	Information management	Product design	Testing
Document control	Information systems & technology	Product development	Vendor relations
Donating	Innovation	Product management	Volunteering
Emergency preparation	Inspection	Waste management	Warehousing
Employee - attendance	Internal communications	Workforce diversity	Warranty

Check Your Progress 1

1) Answer the following:

i) Which are the basic functions of the management and what are the levels of the management? At what level of the management following are decided?

a) Selling of the products to the specific customers.
b) What markets or businesses the company should be in at present?
c) What should be the overall production plan?

ii) What are the significant differences between conventional marketing and modern marketing?

iii) What are business processes? Identify a business process for each functional area.

2) Mark the correct answer.

a) Deciding where to locate new production facilities is an example of a manufacturing and production information system operating at the:

i) operational level. ☐
ii) management level. ☐
iii) knowledge level. ☐
iv) strategic level. ☐

b) Preparing short-term budgets is an example of a finance and accounting information system operating at the:

i) operational level. ☐
ii) management level. ☐
iii) knowledge level. ☐
iv) strategic level. ☐

c) Tracking employee training, skills, and performance appraisals is an example of a human resource information system operating at the:

i) operational level. ☐
ii) management level. ☐
iii) knowledge level. ☐
iv) strategic level. ☐

d) Assembling a product, identifying customers and hiring employees are:

i) transactions. ☐
ii) phases. ☐
iii) business processes. ☐
iv) business functions. ☐

2.4 INFORMATION SYSTEMS REQUIREMENTS

At the turn of the nineteenth century industrial revolution took place. This Industrial Age focused on the role of the *Management*. At present with the rapid development of the Information Technology, a new industrial revolution is in the making, similar to the one that took place at the turn of the nineteenth century. The world is advancing from the *Industrial Age* to the knowledge age. The new challenge to the management which surrounds us requires profound change; profound change in the way we consider the organisations; may be those are part of the Government or civil administration or business enterprise, the way we develop our businesses, the way we manage, and the structures within which we manage.

Productivity and efficiency of business to reduce cost of products and services, and to use technology to continually innovate is nothing new except that the competition is much more fierce than ever before. Globalisation of the marketplace, and means of accessing the same, through national and global information superhighways have given a new dimension to the concept of information. Information and knowledge are critical to mange change, which is the salient feature of the Information Age. Businesses do not have sufficient time to consolidate as there are continuous changes to be handled due to changes in technology, raw materials, customer needs, legislation, rule and regulations.

Information Age is thus knowledge-based. This challenge of providing rapid changing information and thus knowledge base requires a system. As we see thus this Information Age requires focus on *Management* and the *Information Systems,* therefore, we will focus on how the information system needs of the management can be fulfilled.

Information

Information is a necessary and vital input for the Management. Any Management decision-making has to be based on information. Information need to be TRUE. Making use of its acronym we may say information must be Timely, Reliable, Useful, and Explicit.

Timely: It should reach the recipient *in time* and *up-to-date*. For effective decision making information must reach the decision maker at the right time so that he can take the desired action. The delayed information at times can even lead to loss of purpose itself or in substantial loss.

Reliable: Any information can be reliable only if it is *factual, accurate* and *complete.*

Useful: *Relevance* and *adequacy* of the information for the need for which it is required makes it useful to purpose.

Explicit: Quality information is said to be explicit if it does not require further analysis by the recipient for decision-making.

In other words information can be defined as processed data.

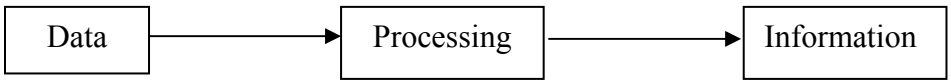

Figure 9: Information processed data

System

In our everyday life, the word 'system' is used quite often. We talk about an educational system, computer system, organisational system, political system, solar system, railway system etc. On analysis we will find we use the word system to mean a collection of elements integrated to achieve a common definable goal. For illustration, a business organisation can be considered as a system, in which the parts (departments, sections and units etc.) are joined together for a common goal. An information system can be a set of collection of elements starting from collection of data, its processing and presentation for achieving a defined or set goal.

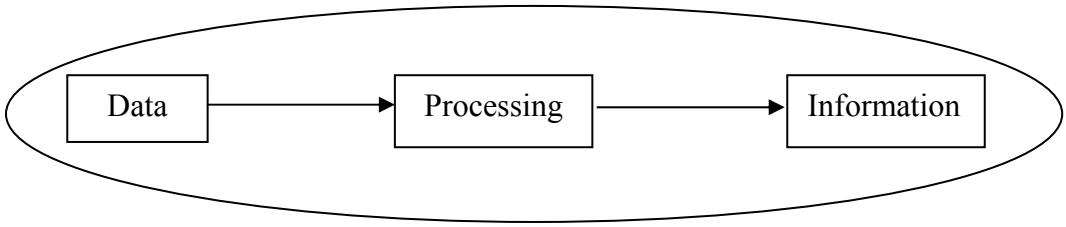

Figure 10: Information system

In business, information systems support business processes and operations, decision-making, and competitive strategies.

Information System

Information System is a set of processes that helps in collecting the data, storing the data, processing the data and disseminating information to support decision making process of key managers.

2.5 REQUIREMENT ANALYSIS

Requirements analysis, in software engineering, is a term used to describe all the tasks that go into the instigation, scoping and definition of a new or altered computer system. Requirements analysis is an important part of the software engineering process; whereby business analysts or software developers identify the needs or requirements of a client; having identified these requirements they are then in a position to design a solution.

Requirements analysis is also known under other names:

- requirements engineering
- requirements gathering
- requirements capture
- operational concept documenting
- systems analysis
- requirements specification.

During most of the history of software engineering it has been considered to be a relatively easy part of the process. However, in the last decade or so, it has become increasingly recognised as being the most vital part of the process; given that the failure to properly identify requirements makes it virtually impossible for the finished piece of software to meet the needs of the client or be finished on time.

The challenge

Successfully completing a “requirements analysis” task is a challenge. In the first place, it is not easy to identify all the stakeholders, give them all an appropriate form of input, and document all their input in a clear and concise format. And there are constraints. The requirements engineer is expected to determine whether or not the new system is

- feasible
- schedulable
- affordable
- legal
- ethical.

In the rush of enthusiasm associated with a new project, there is always a temptation to downplay the importance of requirements analysis. However, studies of various projects reveal that costs and technical risks can be reduced through rigorous and thorough up-front requirements engineering.

General problem

The general difficulties involved with requirements analysis are increasingly well known:

- the right people with adequate experience, technical expertise, and language skills may not be available to lead the requirements engineering activities;
- the initial ideas about what is needed are often incomplete, wildly optimistic, and firmly entrenched in the minds of the people leading the acquisition process; and
- the difficulty of using the complex tools and diverse methods associated with requirements gathering may negate the hoped for benefits of a complete and detailed approach.

Stakeholder issues

Steve McConnell, in his book Rapid Development, details a number of ways users can inhibit requirements gathering:

- Users don't understand what they want.
- Users won't commit to a set of written requirements.
- Users insist on new requirements after the cost and schedule have been fixed.
- Communication with users is slow.
- Users often do not participate in reviews or are incapable of doing so.
- Users are technically unsophisticated.
- Users don't understand the software development process.

This commonly leads to the situation where user requirements keep changing even when the software development has been started. Because new requirements may sometimes mean changing the technology as well, the importance of finalising user requirements before the commencement of development should be made very clear to the Business Users. Knowing their objectives and expectations regarding the solution beforehand and documenting agreed requirements is fundamental to the success of a project.

Developer issues

However, developers are often equally at blame. Typical problems caused by software developers are:

- Software developers and end users often have different vocabularies. Consequently, they can believe they are in perfect agreement until the finished product is supplied. The duty to bridge that gap is often assigned to Business Analysts, who analyse and document the business processes of business units affected by the proposed business solution, and Business Systems Analysts, who analyse and document the proposed business solution from a systems perspective.
- Software developers often try to make the requirements fit an existing system or model, rather than develop a system specific to the needs of the client.
- Analysis is often carried out by programmers, rather than business analysts. It is often the case that programmers lack the people skills and the domain knowledge to understand a business process properly.
- Software developers have pre-conceived notions about the problem.

Solutions

One of the solutions to these problems are to recognise that requirements analysis is a specialist field best carried out by experts, i.e. business or system analysts, who could bridge the gap between the business and IT (Information Technology) world. While this approach has helped, it has often been difficult to find staff who possess equally good people and technical skills. In addition, the techniques used to analyse requirements have not proven sufficiently effective in all situations. Techniques introduced in the 1990s like Prototyping, Unified Modeling Language (UML), Use

cases, and Agile software development are often put forward as a promising solution to this issue.

More recently, however, attempts have been made to address these difficulties with the establishment of the International Institute of Business Analysis, whose main goals are the creation of a common Body of Knowledge for Business Analysis, and to use it as basis for certification of Business Analysis Professionals.Also, a new class of application simulation or application definition tools have entered the market. These tools are designed to bridge the communication gap between business users and the IT organisation — and also to allow applications to be 'test marketed' before any code is produced.

The best of these tools offer:

- electronic whiteboards to sketch application flows and test alternatives
- ability to capture business logic and data needs
- ability to generate high fidelity prototypes that closely imitate the final application
- interactivity
- capability to add contextual requirements and other comments
- ability for remote and distributed users to run and interact with the simulation.

2.6 TOOLS AND METHODS FOR REQUIREMENT ANALYSIS

Requirements analysis can be a long and arduous process. The requirements specialists do their work by talking to people, documenting their findings, analysing the collected information to discover inconsistencies and oversights, and then talking to people again. This process can go on for anywhere from a week to a year or more, and may continue throughout the life cycle of a system.

New systems change the environment and relationships between people, so it is important to identify all the stakeholders, take into account all their needs and ensure they understand the implications of the new systems. Frequently, this objective is not met because:

- there is not enough communication up front and important needs are overlooked when the system is implemented; and/or
- there is not enough ongoing communication during system development and the users are disappointed by the new system's characteristics.

To keep all these discussions well organised and efficient, the evolving requirements must be documented.

Analysts can employ several techniques to get the requirements from the customer. Historically this has included such things as holding interviews, or holding focus groups (more aptly named in this context as requirements workshops — see below) and creating requirements lists. More modern techniques include Prototyping, and use cases. Where necessary, the analyst will employ a combination of these methods to establish the exact requirements of the stakeholders, so that a system that meets the business needs is produced.

Methods for Requirement Analysis:

Stakeholder interviews

Stakeholder interviews are obviously necessary in requirement specification. However, in any large system a number of individuals need to be interviewed which

increases the time and cost. This often leads to pressure to shorten the analysis phase despite the impact incomplete requirements can have on a project. Stakeholder interviews also often reveal major shortcomings with regard to how existing business processes works and identify how to improve this in the future. While this is ultimately a positive for the business, it will also lead to previously unforeseen increases in time and cost. This can be further compounded by the discovery that different users have differing or even contradictory requirements.

Requirement workshops

To overcome these issues, where systems are complex the usual method is to conduct requirement workshops. The analyst brings the main stakeholders in the system together in order to analyse the system and develop the solution. These workshops are more properly termed Joint Requirements Development (JRD) sessions, where requirements are jointly identified and defined by stakeholders.

Such workshops are ideally carried out in a controlled environment, so that the stakeholders are not distracted. A facilitator can be used to keep the process focused and these sessions will often benefit from a dedicated scribe to document the discussion. Facilitators may make use of a projector and diagramming software or may use props as simple as paper and markers. Often multiple workshops are required to bring the process to a successful conclusion.

Requirements workshops are considered to be a very useful technique which can save significant time. However, it can be hard to get all the required stakeholders together at one time.

A more general weakness is that some stakeholders do not contribute forcefully enough in workshops and their requirements will not receive the appropriate attention, inevitably producing a limited solution. Additionally, while requirement workshops are an excellent technique for modelling the existing system, they are not so useful for defining the nature of the solution.

Contract-style requirement lists

One way of documenting requirements has been contract style requirement lists. In a complex system such requirements lists can run to hundreds of pages. An appropriate metaphor would be an extremely long shopping list. Such lists are very much out of favour in modern analysis; as they have proved spectacularly unsuccessful at achieving their aims; but they are still seen to this day.

Strengths:

- Provides a checklist of requirements.
- Provide a contract between the project sponsor(s) and developers.
- For a large system it can provide a high level description.

Weaknesses:

- Such lists can run to hundreds of pages. It is virtually impossible to read such documents as a whole and have a coherent understanding of the system.
- Such requirements lists abstract all the requirements and so there is little context
    - This abstraction makes it impossible to see how the requirements fit together.
    - This abstraction makes it difficult to identify which are the most important requirements.
    - This abstraction means that the more people who read such requirements the more different visions of the system you get.

    - This abstraction means that it's extremely difficult to be sure that you have the majority of the requirements. Necessarily, these documents speak in generality; but the devil, as they say, is in the details.
- These lists create a false sense of mutual understanding between the stakeholders and developers.
- These contract style lists give the stakeholders a false sense of security that the developers must achieve certain things. However, due to the nature of these lists, they inevitably miss out crucial requirements which are identified later in the process. Developers use these discovered requirements to renegotiate the terms and conditions in their favour.
- These requirements lists are no help in system design, since they do not lend themselves to application.

Prototypes

In the mid-1980s, *prototyping* became / seen as the solution to the requirements analysis problem. Prototypes are mock ups of the screens of an application which allow users to visualize the application that isn't yet constructed. Prototypes help users get an idea of what the system will look like, and make it easier for users to make design decisions without waiting for the system to be built. When they were first introduced the initial results were considered amazing. Major improvements in communication between users and developers were often seen with the introduction of prototypes. Early views of the output led to fewer changes later and hence reduced overall costs considerably.

However, over the next decade, while proving a useful technique, it did not solve the requirements problem:

- Managers once they see the prototype have a hard time understanding that the finished design will not be produced for some time.
- Designers often feel compelled to use the patched together prototype code in the real system, because they are afraid to 'waste time' starting again.
- Prototypes principally help with design decisions and user interface design. However, they can't tell you what the requirements were original.
- Designers and end users can focus too much on user interface design and too little on producing a system that serves the business process.

Prototypes can be flat diagrams (referred to as 'wireframes') or working applications using synthesized functionality. Wireframes are made in a variety of graphic design documents, and often remove all colour from the software design (i.e. use a greyscale colour palette) in instances where the final software is expected to have graphic design applied to it. This helps to prevent confusion over the final visual look and feel of the application.

Use cases

A ***use case*** is a technique for capturing the potential requirements of a new system or software change. Each use case provides one or more *scenarios* that convey how the system should interact with the end user or another system to achieve a specific business goal. Use cases typically avoid technical jargon, preferring instead the language of the end user or *domain expert*. Use cases are often co-authored by software developers and end users.

Use cases are deceptively simple tools for describing the behaviour of the software. A use case contains a textual description of all of the ways that the intended users could

work with the software through its interface. Use cases do not describe any internal workings of the software, nor do they explain how that software will be implemented. They simply show the steps that the user follows to use the software to do his work. All of the ways that the users interact with the software can be described in this manner.

During the 1990s use cases have rapidly become the most common practice for capturing functional requirements. This is especially the case within the object-oriented community where they originated, but their applicability is not restricted to object-oriented systems, because use cases are not object oriented in nature.

Each use case focuses on describing how to achieve a single business goal or task. From a traditional software engineering perspective a use case describes just one feature of the system. For most software projects this means that multiple, perhaps dozens, of use cases are needed to fully specify the new system. The degree of formality of a particular software project and the stage of the project will influence the level of detail required in each use case.

A use case defines the interactions between external actors and the system under consideration to accomplish a business goal. Actors are parties outside the system that interact with the system; an actor can be a class of users, roles users can play, or other systems.

Use cases treat the system as a "black box", and the interactions with system, including system responses, are as perceived from outside the system. This is deliberate policy, because it simplifies the description of requirements, and avoids the trap of making assumptions about how this functionality will be accomplished.
A use case should:

- describe a business task to serve a business goal
- be at the appropriate level of detail
- be short enough to implement by one software developer in single release.

Use cases can be very good for establishing the functional requirements; however they are not suited to capturing Non-Functional Requirements.

Software Requirements Specification

A ***software requirements specification*** (SRS) is a complete description of the behaviour of the system to be developed. It includes a set of use cases that describe all of the interactions that the users will have with the software. In addition to use cases, the SRS contains functional requirements and nonfunctional requirements. Functional requirements define the internal workings of the software: that is, the calculations, technical details, data manipulation and processing, and other specific functionality that shows how the use cases are to be satisfied. Nonfunctional requirements impose constraints on the design or implementation (such as performance requirements, quality standards, or design constraints).

Stakeholder identification

A major new emphasis in the 1990s was a focus on the identification of **stakeholders**. This first step is now seen as critical. In the early days systems were built for the projects sponsor(s), who were usually management types. Many systems have been designed by managers with little or no contributions from the eventual users; these systems have tended to fail horrendously. So within the field of software engineering, in the 1970s and 1980s, the understanding of the term stakeholder widened to the main users of the system, and then peripheral users. However, since the 1990's the search for stakeholders is taking on a more whole system approach. It is increasingly

recognised that stakeholders do not just exist in the organisation the analyst is hired by. Other stakeholders will include:

- those organisations that integrate (or should integrate) horizontally with the organisation.
- any back office systems or organisations.
- higher management.

Successful identification of the stakeholders ensures that analysis will take into account the right elements.

Tools for Requirement Analysis

Use of proper tools for requirement analysis helps in avoiding rework, which typically accounts for 40% of a development organisation's total spend — time, and money that organisations cannot afford in today's highly competitive business landscape. Most of this rework effort focuses on correcting requirements defects, which could cost 50 to 200 times as much as defects that, are corrected close to the point of creation.

It is important for IT organisations to deliver software Requirements Definition and Management Solution at less cost by getting requirements right the first time and ensuring business IT alignment throughout the software lifecycle. In addition the approach needs to be that it takes into account an organisation's process maturity and leverages industry best practices to evaluate current performance and identify specific areas for improvement. The tool should provide a scalable, integrated Software Requirements Definition and Management solution that enables IT organisations to:

Define: Produce accurate and complete requirements by eliciting, specifying, analysing, and validating requirements early, reducing costly rework later in the development lifecycle.

Manage: Deliver the right product the first time, every time by tracking progress, communicating changes and focusing resources.

Verify: Ensure quality by tracing requirements though implementation to testing.

The tool should help organisations answer the following key questions:

How can we define accurate and complete requirements?
How can we document or specify requirements to communicate them without ambiguity?
How can we perform impact analysis and prioritisation on changing requirements?
How can we effectively manage project scope?
Process-Led Approach for Improving Software Requirements Definition and Management.

The tool should help meeting the following Five *Critical Process Areas in Software Requirements Definition and Management:*

- Elicitation
- Analysis
- Specification
- Validation
- Management.

Elicitation

To eliminate rework, steps need be taken to help organisations mature their existing requirements elicitation process by:

- Selecting appropriate stakeholders,
- Identifying appropriate elicitation techniques,
- Training team members, including business partners, business analysts, systems analysts, architects and others, to use the preferred techniques with the appropriate stakeholders,
- Customizing templates for elicitation, and
- Capture user scenarios in a simple visual form that users readily understand.

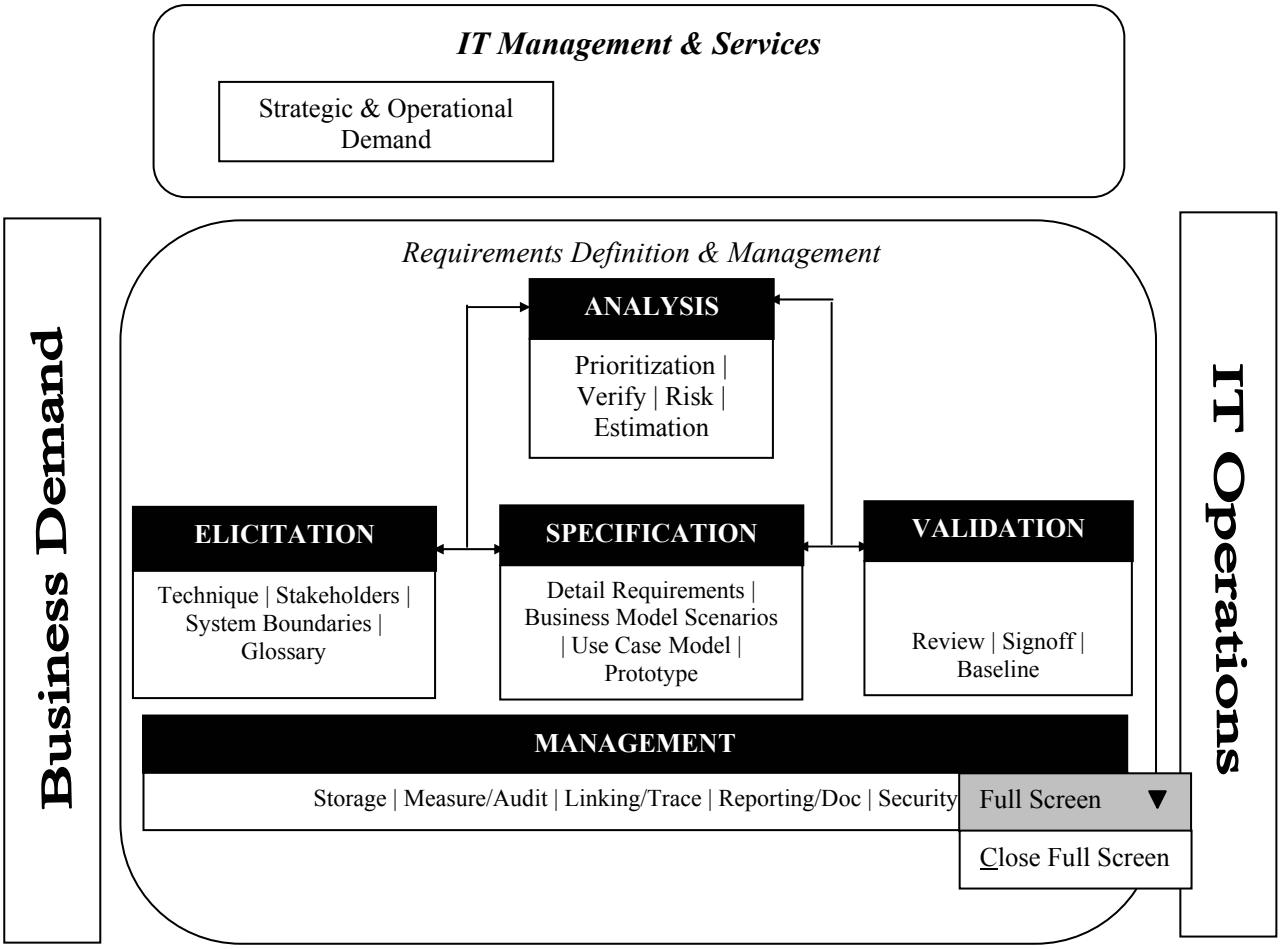

Figure 11: The five critical requirements definition and management process areas analysis

Analysis

To ensure the most important business requirements are delivered, steps need be taken so that organisations mature their existing analysis process by:

- Implementing an effective approach for evaluating and prioritising requirements,
- Enhancing the skills of analysts for analysing and clarifying requirements, and
- Enabling a robust, requirements-based estimation and planning process.

IT organisations deliver increased value to business stakeholders based on greater alignment between business and IT, while business stakeholders deliver more value to their customers because priorities are aligned with IT. The organisation also gains better estimation and thus, improved predictability of system deliveries.

Specification

To improve accuracy and relevancy, organisations may mature their existing requirements specification process by:

- Defining a consistent hierarchy of requirement types, attributes and traces, so all stakeholders can easily find, filter and sort on the most relevant data,
- Developing standard templates for each requirement scenario to ensure completeness,
- Identifying various specification techniques (e.g., use case models, business process models, prototypes, and traditional requirements specifications) and their appropriate use so that requirements are captured in a meaningful, easy-to-understand way,
- Configuring a tools infrastructure to support custom templates and integrations,
- Training development teams in the appropriate use of the tools,
- Providing automated trace ability across the various requirements types,
- Training team members to leverage traces throughout the lifecycle to achieve overall project control, and
- Leveraging selected technology to detail requirements with attributes, trace ability, screenshots, images, office documents and more to make requirements clear and understandable to drive development most effectively.

Validation

To improve accuracy and completeness, organisations may mature their existing requirements validation process by:

- Defining and implementing a verification process with clear quality metrics to reduce defects,
- Automating validation and verification processes through the storyboard execution to drive process adoption and enforcement and improve consistency and quality, and
- Defining and implementing a process for validating requirements with stakeholders that ensures requirements signoff.

Management

To maximize responsiveness and control, organisations may mature their existing requirements management process by:

- Establishing processes for managing changes to existing requirements, including a standard process for requesting changes to enable better control of scope and commitment, improved impact analysis and more reliable project planning, and
- Defining procedures for evaluation and acceptance among stakeholders — in some cases establishing a Change Control Board.

With the use of the appropriate tool, organisations are expected to improve their ability to handle ongoing changes, maximizing business impact, while minimizing schedule and scope impact, gain greater ability to manage the ever-increasing requests from business teams in a collaborative, factual way, and increase business stakeholder satisfaction because development is more responsive, delivering the right software on time and within budget.

Requirement Analysis Tools

Large numbers of Requirement analysis tools are available commercially as can be seen in the following list (in alphabetical manner). This list also indicates the suppliers of these tools as well as the Salient features of the tools have been described.

Accept 360° from Accept Software Corporation is a requirements management tool that also supports product planning. Tools help users to define and track feature dependencies with tree diagrams, and to relate these to the market, project plans, implementation considerations and competitor analyses.

Active Focus from Xapware supports the software application life cycle.

Agility from Agile Edge is a tracking database for user requirements, issues, tasks and bug tracking, permitting tracing between these items. There is a simple user interface displaying a table of items with status, symbols and text.

AnalystPro from Goda Software supports requirements editing and trace ability, change control, diagrams including use cases, and other features of full RM tools at a low price per seat.

Kris of Goda Software, Inc: Analyst Pro is an affordable, scalable and collaborative tool for requirements tracking, trace ability analysis and document management. It is easily deployable and customizable to the project needs."

Caliber-RM from Borland is a well-known requirements management tool. It is intended for large and complex systems, and provides a database of requirements with trace ability. This tool views requirements as part of the software quality management process, which it considers and also includes testing and defect tracking. Caliber is Internet-based, and it handles document references, user responsibility, trace ability, status and priority.

Chip Carey of Starbase (former owners of Caliber): "The exciting thing about RM and Caliber RM in particular is that it brings all departments together within the software development lifecycle and puts them all on the same page — it provides a mechanism for communication and collaboration and effectively provides a synergy where before they were perhaps separate efforts and maybe counter-productive."

C.A.R.E. from Sophist Group is a Lotus Notes-based tool which provides a database-like view of requirements. The website is in German but the tool's GUI is in English. Using the hypertext-like Lotus Notes is an interesting approach to organising requirements with obvious practical advantages, and the Sophist Group is noted for its Object-Oriented thinking. The tool provides a wide range of features and produces both textual and graphical outputs.

Cradle from 3SL Cradle is a multi-user, multi-project, distributed and web-enabled requirements management and systems engineering environment. It is intended for all sizes of requirements and systems development projects. Cradle can link to corporate PDM/EDM systems. It offers configuration management, edit histories and version control. It automates document production and can manage the generated documents. Through its web interface, it can integrate disparate stakeholder groups by creating customizable read-write portals to all project data.

Mark Walker of 3SL Cradle can deliver unlimited requirements and systems modeling scalability to the desktop through web and non-web methods that allow capture and parsing of requirements and their traceability through every part of all C4ISR, ISO, DoD and INCOSE recommended processes.

Clear Requirements Workbench (CRW) from LiveSpecs Software helps specify, verify, and manage detailed requirements. CRW supports four detailed specification techniques (glossaries, action contracts, test procedures, and precise use cases) for the clear description of definitions, behaviour, and usage. David Gelperin of LiveSpecs Software: Clear Requirements Workbench is the first system to actively support the detailed requirements that put customers, users, managers, marketers, developers, testers, and technical writers on the same page.

DocuBurst from Teledyne Brown Engineering is a package that discovers requirements and headings in text documents, and structures them into objects for use in requirements and other tools. It runs on Windows, and generates XML, TSV, CSV, and other file types. It is compatible with most tools including TBE's own XTie-RT.

Sherry Adlich Using DocuBurst to 'burst' a text document into pieces eliminates days of effort typically spent to analyse documents for information gathering or requirements gathering.

Doors from Telelogic Doors is a tool primarily for large organisations which need to control complex sets of user and system requirements with full trace ability. It provides good visualization of such documents as hierarchies, and its extension language enables a wide range of supporting tools to be built, and many are provided as menu commands and examples. Further options include DoorsNet which allows controlled interaction over the Internet, and the Change Proposal System which automates the requirement review cycle. There are live interfaces to many CASE tools, and the promise of tight integration with Telelogic's market-leading Tau toolkit for specification, design, and testing based on UML and the SDT approach to real-time systems development centred on telecommunications. Its use is therefore moving towards integrated project support.

Nancy Rundlet of Telelogic says: With DOORS, we provide worldwide support, Word-like ease of use, scalability from 1 user to several hundred, and ease of establishing traceability and displaying it to multiple levels.

Focal Point (now owned by Telelogic) is a market-driven requirements management tool. It incorporates customer collaboration, prioritization and visualization and decision-making and planning processes inside a tailorable web-based platform. It links requirements to market segmentation, competitor analysis, release planning and other processes in product life cycle management.

Gatherspace is a free requirements management and use case development tool that offers multi-user and team functionality. The system is an online solution with different user-tiered packages. There are a variety of reports from basic functionality reports to use case models.

1) Gatherspace is totally online, no software to download;

2) Designed and coded by analysts and project managers who full understand the process of gathering requirements;

3) With an intuitive GUI, Gatherspace also provides a todolist of "what's next" to create in addition to defining analyst-based terms.

GMARC from Computer System Architects GMARC was one of the earliest RE methods (conceived 1982) and has been continuously developed ever since. Its development was sponsored by the UK's DTI in 1990 together with the CAA, the MoD, NERC, City University and Kings College London. GMARC is claimed to be unique in its ability to reduce project/programme risk.

Brian Hunt of CSA writes: GMARC was initially developed to be able to accumulate multi-layer generic requirements knowledge for subsequent re-use, via automated elicitation, in any application domain. The latest version is able to use such knowledge to progressively improve its ability to understand the semantics of, and capture new requirements in, each domain. To aid the process of understanding an application, GMARC provides a suite of powerful requirements animation facilities. These are able to be used to verify and explore the functional aspects of any specification. In

order to take subjectivity out of the process (a universal problem!), GMARC employs a multitude of objective quality metrics to guide requirements development activity.

iRise from iRise.com is a tool for previewing or prototyping a software application before doing any coding. In the process, the requirements are "completely and unambiguously fleshed out - including application and page flows, user interfaces, business logic, data structures and other requirements."

IRqA from TCP Sistemas e Ingeniería IRqA is a Requirements Engineering (RE) tool specifically designed to support the complete RE process. In IRqA the complete specification cycle including requirements capture, analysis, system specification, validation and requirement organisation is supported via standard models.

Antonio Monzón, then of TCP Sistemas e Ingeniería: "with IrqA, we cover the full requirements specification cycle, not only RM and capture but also analysis, specification — features related to the construction of a specification; we have graphical, visual features like State Machines, Use Cases, graphical structuring of specifications — functional, non-functional, test cases, diagrams of review processes, information models, link matrices."

Jalsoft from Jalsoft is a web-based RM tool. The tool contains a database (DB2, Oracle or SQL/Server) and an ordinary web server at the server end; the thin client is simply a web browser, so installation is trivial and learning is said to be a matter of minutes. The tool integrates with Word, MS Office and MS Project; there is an XMI interface to other tools, and CSV file import and export. The tool can therefore be used 'from anywhere in the world'. RM functions like trace ability, history, base lining and reporting are provided.

Leap SE from Leap Systems Leap SE is a requirements engineering CASE tool that produces object-oriented models directly from a system requirements repository or specification (SRS). A 30-day trial version is available.

Brian Smith of Leap Systems writes: "By translating English into logical models for software development, Leap SE achieves RAD from the source, dramatically shortening the systems analysis phase for software projects."

MKS Requirements 2005 from MKS MKS Requirements 2005 is a 'right-weight' RM tool built as an integral part of a Configuration Management system (MKS Integrity Manager, via its process/workflow engine). It integrates with Microsoft Word, organizes requirements hierarchically, provides history, metrics, traceability to source code, suspect links, etc. Low cost of ownership is claimed.

The vendor claims: "the clear connection between requirements, development activity and development artifacts delivers an unprecedented level of audit-ability, something every IT organisation must demonstrate for Sarbanes-Oxley compliance."

MockupScreens from Igor Jese MockupScreens is a rapid User Interface prototyping tool. You create screen mockups and organise them into scenarios, complete with buttons, fields, lists etc. Free evaluation copy from website.

Objectiver from Cediti Cediti is a spin-off from the University of Louvain, Belgium (UCL), and the tool is based on the KAOS method of analysing goals devised by Prof. Axel van Lamsweerde. The tool thus has a solid foundation (capable of formal proof) for modeling goals, requirements, agents, entities, events relationships, actions, etc., with all the relationships between them (cause-effect, conflict, instance-of, goal refinement, etc.), supported by editable diagrams.

The vendor claims that key advantages of Objective are:

- it enables analysts to elicit and specify requirements in a systematic way,
- it produces well structured, self-contained, motivated, easily understandable, standard requirements documents,

- it provides highly effective way to communicate about the requirements,
- it ensures trace ability from requirements to goals and from high-level, coarse-grained behavioural specifications to requirements.

OPEN Process Framework (OPF) from Firesmith Consulting:

This remarkable toolkit contains a repository of reusable process components for building project-specific processes for software-intensive systems — complete, hook, line and sinker. There are numerous reusable process components including work products (from requirements, diagrams, models, documents to components), work units (activities, tasks, and techniques), producers (roles, teams, organisations), enterprises (projects, programs, enterprises), and stages (development cycles, phases, milestones). Requirements are supported in detail including document content and format standards, templates, inspection checklists, and guidelines.

Rally from Rally Software Development This is a tool intended specially to support Agile software development.

RDT from IgaTech Systems RDT is a relatively simple tool from an Australian company. It is based on Microsoft Office, but with numerous custom forms (pop-up windows) for entering settings, attributes, etc., and for displaying results. Thought has been given to getting requirements in from ordinary Word documents, and to producing documents as reports by filtering, selecting attributes, and formatting. This seems to make it intermediate between 'light' products like Require IT and Requisite Pro, and 'full' products like DOORS and RDD. 'Capture' is interpreted simply as 'import and extraction'. The tool wisely encourages users to record design rationale.

Gordon Brimble of IgaTech: RDT provides highly capable document handling for parsing input documents and creating output documents, capture of derivations that link derived requirements to record the logic behind requirement flow down and integration with requirements modeling tools.

Reconcile from Compuware This is one of a suite of tools focused on quality assurance and change management.

Reqtify from TNI-Valiosys This is one of a suite of tools designed to assist the development of mission- and safety-critical software (in C, C++, Ada) for aerospace, defence, and industry.

Rectify is a low-cost traceability and impact analysis tool. It is said to take just 1/2 a day to learn. It interfaces to Word and other word processing tools, the other TNI-Valiosys modeling tools, Simulink, etc. It has been applied on Airbus A380 computer projects (alongside RTM) with thousands of requirements and links. Interestingly, the tool is document-centric: requirements are tagged by the user in the source documents; the tool searches for these tags each time a source document is saved, and makes a snapshot of the requirements so discovered.

Lionel BURGAUD of TNI-Valiosys: For project and quality engineers who need to track requirements across the development cycle, Reqtify (tool) is a low-cost, highly customizable and easy to use tool that manages requirements traceabitity, impact analysis, filtering and versioning. Unlike other database tools, Reqtify (tool) processes information directly extracted from the source files (text processing, Excel, PDF, UML, analysis & modelling, code, etc.) without requiring any modifications, and therefore can be very quickly deployed even on projects already started.

RequireIT from Telelogic DOORSrequireIT is Doors' little sister. It is effectively a rival to Requisite Pro, as it is a Microsoft Word tool in which users edit and mark up a Word document with hidden fields that function as custom attributes (owner, status, date, etc.) and as traceability links between requirements. RequireIt is simple to use and does not involve the complexity of reliance on a database as well as on Word, so it

is easier-to-use tool than its rivals, and may be more reliable. It is implemented entirely separately from Doors (it uses Word macros not compiled code) and is intended for use on small projects.

Requisite Pro from IBM Rational Requisite Pro aims especially at managing change in requirements, with traceability for software and test specifications. It is closely linked to Microsoft Word, and Rational is a Microsoft Development Partner. The tool permits the use of Oracle on Unix or Windows as the back-end database, and also supports SQL server on Windows. Rational in 2003 merged with IBM which might mean many things, such as a greater focus on research and consultancy, perhaps.

Jim Heumann of Rational (former owners of RequisitePro): Rational is about tools but also about services, lots of teams locally that serve people, best practices and thought leadership, and of course our goal is to help people write better software — in a nutshell.

RETH, a freeware prototype owned by Siemens, created by Dr. Hermann Kaindl RETH (Requirements Engineering Through Hypertext) is a simple RM tool that demonstrates some powerful aspects of RE. It constructs a set of goals, scenarios, and requirements, each fully-documented with built-in and custom attributes, and inter-connected with hyperlinks. Models can be exported to documents and to HTML.

Rhapsody from I-Logix Rhapsody is an Object-Oriented Analysis and Design tool for embedded software. The emphasis is rather on design, with analysis using UML to describe objects for subsequent detailed design and code generation.

ScenarioPlus ScenarioPlus for Use Cases is a set of free add-on tools for use with Doors. It installs as a menu on the Doors menu bar, and provides for editing and analysing a set of UML-style use cases. Metrics and checklists are provided. There is a strong emphasis on requirements elicitation with easily-understood graphics, generated automatically. The toolset is closely integrated with Doors allowing for complete flexibility in filtering, traceability and reporting.

The site also offers a suite of Microsoft Office templates for scenario-based requirements engineering; tools for editing a range of software engineering diagrams, and tools for functions such as filtering and constructing Doors templates.
Ian Alexander writes: my aim with Scenario Plus is to improve the engineering of systems (not just software) by encouraging the use of state-of-the-art techniques for requirements elicitation, specification, and validation, including means such as scenarios, graphics, metrics, and templates.

Free Prototype Educational Tools for Systems and Software Engineering from SEEC

The Systems Engineering & Evaluation Centre at the University of South Australia (UniSA) offers a suite of free tools that “can be used in the classroom and in the workplace”. The tools include the fancifully-named TIGER, ACE, ET, CARP and RAT (ahem. I recall the immortal line from another project back in 1991 “RAT tool is mouse-driven”). These stand for:

Tool to InGest and Elucidate Requirements (TIGER), i.e., free text extraction with keywords
Acceptance Criteria Elucidator (ACE), i.e., editing the criteria in a database
Requirement Enhancing documentation Tool (ET), i.e., attribute editing
Comparison Analysis of Requirements Priority (CARP), i.e., prioritization
Risk documentation and profiling Tool (RAT), i.e., risk attribute editing.
It can be seen that these form a single basic RM environment. They have “a similar user interface”.

Serena RTM from Serena is an RM tool providing Word and Web Browser interfaces, discussion threads and change requests, traceability analysis and change management. Any life-cycle method can be supported. The data reside in an Oracle database. The tool forms part of a suite including TeamTrack, a process management tool; ChangeMan, a change management tool; Serena Professional, a configuration management tool; and Collage, a web content management tool.

SpeeDEV from SpeeDEV This product takes the approach that requirements in a distributed project need to be developed on the Web. It is claimed to be suitable for hardware as well as software, and covers requirements gathering, "scrubbing", approving, prioritizing, assigning to version releases, task management, testing, bug tracking and other functions. This sounds as if the toolkit will suit some kinds of project very well, but might prove restrictive if the way the tasks are supported isn't what your project wants. The Web is clearly the way more tools will go, so expect hot competition in this area.

Irene From of SpeeDEV: SpeeDEV operates in a completely Web-based environment to promote the free exchange of information and project team participation. SpeeDEV's solution is the only commercial browser-based solution for local or remote software development collaboration, available as enterprise software.

Statestep from Statestep is a free specification tool based on a state model. The user interface allows required behaviour to be defined in decision tables. The tool helps to check systematically that all unusual cases are considered. The resulting model is a finite state machine, which can be checked automatically for completeness and consistency, e.g., that no undesirable state is reachable. The tool has been used commercially to specify consumer electronic systems.

Michael Breen writes: "As a relatively specialised tool based on creating a model of behaviour, it's a bit different to most of the tools in your list... Anyway, one sentence could be:
"Among other things, Statestep features a unique colour-based interface which makes it feasible to deal systematically with (for example) millions of possibilities — and so to find obscure problem cases otherwise likely to be overlooked in a specification."

Steeltrace (formerly Catalyze) from Steeltrace takes a structured view of requirements, breaking them into Functional (in the form of a Use Case-like storyboard structure of main flow, alternative flows etc.) and non-functional requirements (qualities and constraints). These map seamlessly to functional test cases, UML activity diagrams, requirements based milestones in project plans etc. Ease of use is emphasised.

"SteelTrace lets everyone work together easily to define, communicate and understand project requirements so that business, development, and test deliver quality software faster. Reduce over-runs, re-work and time to delivery. Maximize project quality and ROI." -- Tadhg O'Brien

Teamcenter from UGS includes a requirements tool (formerly Slate): "Industrial Strength Groupware for managing requirements, architecting systems, and accelerating product development". Tools cover design and testing as well as requirements. The examples on the website include radar and aircraft carrier, so there is a perceptible military-industrial orientation. The tool provides for conventional box-and-arrow diagrams, but also allows document and object hierarchies, and arbitrary traceability linking. An interesting feature is a budget which provides a recursively added hierarchical spreadsheet for each attribute ('technical allocatable' in Slate jargon) which is to be budgeted. Slate is apparently genuinely object-oriented and as such should suit large industrial projects that want to use OO analysis and design.

Some systems engineers see Slate as a tool that mainly supports the life-cycle after the requirements phases. It provides limited support for requirements capture.

Harold Knight of SDRC (an earlier owner of Slate): Slate is fundamentally different in Systems Engineering because we manage all components of the design in true Object-Oriented fashion — not documents or paper but information, so we are a system design tool — system engineers can design and view systems from any perspective.

Team-Trace from WA Systems is a requirements management tool released in 2002. Ben Sutton of WA Systems: We believe that Team-TRACE is a breakthrough in cost-effective requirements management. It offers all of the relevant features found in other tools at a fraction of the cost. Behind an intuitive interface lies an impressive platform that enables you to capture, analyse, evaluate and trace complex requirements. **Tiger Pro** is one of the free tools.

Truereq from Truereq Inc.

Truereq is a web-based requirements management tool. There is an open (XML) data interchange format, and the API permits custom integration and scripting. Currently (Feb 2004) Truereq offer a free single-user license.

Todd Berger of Truereq writes: Using Truereq, you can manage your product development process in a centralised workspace shared by all your team members. Truereq's integrated toolkit helps you focus on making better products, more quickly, efficiently, and at a dramatically reduced cost.

Vital-Link from Compliance Automation

Ivy Hooks' company produces a database-centred requirements management tool that seems to be well liked.

The **Volere** Template from The Atlantic Systems Guild

The Volere Template is a comprehensive list of all the components that the Robertsons recommend should go into a requirements specification. It is closely associated with the Volere method described in their book, but contains many useful suggestions that could enhance any requirements method. The template can be used with any general RE tool or simply with word-processed documents.

WIBNI from Project Toolbox

(Wouldn't It Be Nice If ...?) is a very low cost RM tool based on Microsoft Access, (like Requisite Pro and DoorsRequireIT). It records priority, status, type, and other attributes, documents links between requirements, keeps an audit trail, exports to Word, and enables sorting and filtering like much heavier tools. Interestingly it also supports event-driven and use-case analysis. There is a free evaluation version.
John Richards of Project Toolbox writes: "I've been managing projects for many years and could not find a requirements database I wanted to use at a price I could justify. I knew what I wanted though, so in the end I developed it."

XTie-RT from Teledyne Brown Engineering (TBE)

TBE released XTie-RT commercially in July 1996. The tool was initially developed for in-house use to assist with proposal development, regulation compliance on environmental programs and large complex systems for the US Army and NASA. It encourages users to document the reasons for decisions.

Users are equally divided between Government contractors and Commercial industry, and between hardware and software. The tool is claimed to be simple to learn, robust and full featured. TBE consider Doors their primary competitor.

Check Your Progress 2

1) State True or False.

i) An information system can be a set of collection of elements starting from collection of data, its processing and presentation for achieving a defined or set goal. True ☐ False ☐

ii) Software developers and end users have same vocabularies. Consequently, they can believe they are in perfect agreement and accordingly the finished product is supplied. True ☐ False ☐

iii) Contract-style requirement lists for requirement analysis are few in number even for a complex system. True ☐ False ☐

iv) Each use case focuses on describing how to achieve several business goals or tasks. True ☐ False ☐

v) Use cases are simple tools for describing the behaviour of the software. True ☐ False ☐

2) Answer the following:

a) What are the challenges and problems of Requirement Analysis?

……
……
……

b) What are the tools and methods for carrying out Requirement Analysis?

……
……
……

2.7 SUMMARY

This completes our discussion regarding management functions and requirements it has to meet at various levels for managing the organisations. We also completed the discussion on business functions and business processes. This understanding was further carried forward to understand system requirements and how different tools and methods can be used for this so that system developed with this understanding meets the desired requirements and needs of the organisation.

This discussion will be carried forward in the next unit for further understanding the types of management systems and what systems are being used for meeting the present day challenges.

As said earlier at end of the unit 1, it is once again suggested that the students must supplement this study with the case studies on these topics.

2.8 SOLUTIONS / ANSWERS

Check Your Progress 1

1)

i) The basic functions of the management are:

- Planning,
- Organising,
- Coordinating,

- Directing, and
- Controlling.

Levels of the management are:

- Top/Strategic
- Middle Management
- Operational level

The level of the management at which the following are decided are as indicated before each:

a) Operational Management.

b) Top/ Strategic level.

c) Middle Management.

ii) The significant differences between conventional marketing and modern marketing are:

a) Used of traditional marketing, the product is produced and the product is pushed to the market with aggressive selling and promotional efforts while in modern marketing activities start with exploring and understanding customers' need even before the product is produced, so that the product is designed keeping customers needs in mind.

b) As per traditional practices, marketing start with selling and promotion to attain sales at a profit, while modern marketing focuses its attention on customers / buyers. It gets profit through the creation of the buyer's satisfaction and further, seeks to achieve it through an integrated, corporate wide set of marketing activities.

iii) The business process can be defined as any function within an organisation that enables the organisation to successfully deliver its products and services.

One typical business process for each functional area is given in the following table:

Sl. No.	Functional Area	Typical Business Process
1	Sales / Marketing	Selling the product
2	Manufacturing / Production	Assembling the product
3	Finance / Accounts	Creating financial statements
4	Human Resource	Hiring employees
5	Other types- Materials	Carrying out inventory control

2) Mark the correct answer

a) Deciding where to locate new production facilities is an example of a manufacturing and production information system operating at the:

i)	operational level.	
ii)	management level.	
iii)	knowledge level.	
iv)	strategic level.	Y

b) Preparing short-term budgets is an example of a finance and accounting information system operating at the:

i)	operational level.	
ii)	management level.	Y
iii)	knowledge level.	
iv)	strategic level.	

c) Tracking employee training, skills, and performance appraisals is an example of a human resource information system operating at the:

i)	operational level.	Y
ii)	management level.	
iii)	knowledge level.	
iv)	strategic level.	

d) Assembling a product, identifying customers and hiring employees are:

i)	transactions.	
ii)	phases.	
iii)	business processes.	Y
iv)	business functions.	

Check Your Progress 2

1) i) True, ii) False, iii) False, iv) False, v) True

2) a) The challenge for requirement analysis are due to the fact that:

i)

- it is not easy to identify all the stakeholders,
- it is not easy to document all their input in a clear and concise format, and

ii) it is required to be to determine whether or not the new system is:

- feasible
- schedulable
- affordable
- legal
- ethical

The problems are due to:

- Difficulty in availability the right people with adequate experience, technical expertise, and language

- the initial ideas about what is needed are often incomplete, wildly optimistic, and firmly entrenched in the minds of the people, and
- the difficulty of using the complex tools and diverse methods associated with requirements gathering

b) The tools and methods of requirement analysis are:

- Stakeholder interviews
- Requirement workshops
- Contract-style requirement lists
- Prototypes
- Use cases
- Software Requirements Specification
- Stakeholder identification.

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UNIT 3 MANAGEMENT SYSTEMS

Structure **Page No.**

3.0 INTRODUCTION

In the previous unit, we discussed the diverse requirements which the management has to meet for achieving the goals of the organisation. In this unit, we will carry this discussion further to discuss what assistance information systems can provide to the manager for efficiently discharging his responsibilities. A manager has to carry out the role of a functional expert, carry out decisions, plan and co-ordinate for which he/she has to perform the role of a communicator and control all the activities under his/her responsibility. Depending upon his/her position/level in the hierarchy a manager has to carry out strategic, managerial or operational responsibilities. We will discuss how by providing an appropriate system a manager can be helped.

3.1 OBJECTIVES

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

- understand basics of management systems and their types;
- describe the management systems for the roles a manager has to fulfil, and
- design the Information systems required at various levels of management.

3.2 MANAGEMENT SYSTEM TYPES

Management systems are the formal, observable ways in which an organisation administers its operations. We can also say a management system provides the framework of processes and procedures used to ensure that an organisation can fulfil all tasks required to achieve its objectives. For instance, an environmental management system enables organisations to improve their environmental performance through a process of continuous improvement. An oversimplification is “Plan, Do, Check, Act.” A more complete system would include accountability (an assignment of personal responsibility) and a schedule of activities to be completed, as well as auditing tools to implement corrective actions in addition to scheduled activities, creating an upward spiral of continuous improvement.

Because there are different interests, specialities, and levels in an organisation, there are different **management systems types**. No single system can provide all the information an organisation needs. More and more of these management systems are being covered under computerization; some of the management systems that have been computerised in various organisations are given below:

- Administrative management system

- Human resources management system
- Accounting management system
- Customer relationship management system
- Knowledge management system
- Logistics management system
- Marketing management system
- Operations management system
- Project management system
- Process management system
- Personal management system
- Product management system
- Quality management system
- Resource management system
- Risk management system
- Supply chain management system
- Time management system.

Some of these Management Systems operate only at a specific management level, whereas, some operate across management levels. Some operate within one management function, whereas some operate across management functions.

3.3 MANAGEMENT SYSTEM REQUIREMENTS

Efficient and effective operation of a business requires a management system, which can support business processes and operations, decision-making, and competitive strategies.

In the unit 2.2, we discussed using the functional approach and tried to answer the question, what do managers do? We observed that the managers plan, organise, coordinate, direct and control. Now let us look at what functions management systems do? or why management systems are required? In addition to the broad categories of management functions, managers at different levels of the hierarchy fill different managerial roles. Let us look at these roles:

The functional support role

Business processes and operations support function are the most basic. They involve collecting, recording, storing, and basic processing of data. Information systems support business processes and operations by:

- Recording and storing *accounting records* including sales data, purchase data, investment data, and payroll data,
- Processing such records into financial statements such as income statements, balance sheets, ledgers, and management reports, etc.
- Recording and storing inventory data, work in process data, equipment repair and maintenance data, supply chain data, and other production/operations records,
- Processing these operations records into production schedules, production controllers, inventory systems, and production monitoring systems,
- Recording and storing such human resource records as personnel data, salary data, and employment histories,
- Processing these human resources records into employee expense reports, and performance based reports,
- Recording and storing market data, customer profiles, customer purchase histories,
  marketing research data, advertising data, and other marketing records,
- Processing these marketing records into advertising elasticity reports, marketing plans, and sales activity reports,
- Recording and storing business intelligence data, competitor analysis data, industry data, corporate objectives, and other strategic management records, and

- Processing these strategic management records into industry trends reports, market share reports, mission statements, and portfolio models.

The bottom line is that the information systems use all of the above to implement, control, and monitor plans, strategies, tactics, new products, new business models or new business ventures.

The decision role

Decisional roles require managers to plan strategies and utilise resources. There are four specific roles that are decisional. The *entrepreneur* role requires the manager to assign resources to develop innovative goods and services, or to expand a business. Most of these roles will be held by top-level managers, although middle managers may be given some power to make such decisions. The *disturbance handler* corrects unanticipated problems facing the organisation from the internal or external environment. Managers at all levels may take this role. For example, first-line managers may correct a problem halting the assembly line or a middle level manager may attempt to address the aftermath of a fire in the store. Top managers are more likely to deal with major crises, such as requiring a recall of defective products. The third decisional role, that of *resource allocator,* involves determining which work units will get which resources. Top managers are likely to make large, overall budget decisions, while middle managers may make more specific allocations. In some organisations, supervisory managers are responsible to determine allocation of salary raises to employees. Finally, the *negotiator* works with others, such as suppliers, distributors, or labour unions, to reach agreements regarding products and services. First-level managers may negotiate with employees on issues of salary increases or overtime hours, or they may work with other supervisory managers when needed resources must be shared. Middle managers also negotiate with other managers and are likely to work to secure preferred prices from suppliers and distributors. Top managers negotiate on larger issues, such as labor contracts, or even on mergers and acquisitions of other companies.

The interpersonal role

Interpersonal roles require managers to direct and supervise employees and the organisation. The *figurehead* is typically a top of middle manager. This manager may communicate future organisational goals or ethical guidelines to employees at company meetings. A *leader* acts as an example for other employees to follow, gives commands and directions to subordinates, makes decisions, and mobilises employee support. Managers must be leaders at all levels of the organisation; often lower-level managers look to top management for this leadership example. In the role of *liaison,* a manager must coordinate the work of others in different work units, establish alliances between others, and work to share resources. This role is particularly critical for middle managers, who must often compete with other managers for important resources, yet must maintain successful working relationships with them for long time periods.

The communication role

Information systems can support a company's competitive positioning. Here are three levels of analysis:

1) The supports for help in piloting the chain of internal value. They are the most recent and the most pragmatic systems within the reach of the manager. They are the solutions to reductions of costs and management of performance. They are typically named "Business Workflow Analysis" (BWA) or "Business Management Systems (BMS)". They ensure control over piloting the set functions of a company. The real-time mastery in the costs of dysfunctions, cause distances from accounts, evaluation and accounting that are presented in the evaluation and qualitative reports.

2) All successful companies have one (or two) business functions that they do better than the competition. These are called core competencies. If a company's core competency gives it a long-term advantage in the marketplace, it is referred to as a sustainable competitive advantage. For a core competency to

become a sustainable competitive advantage it must be difficult to mimic, unique, sustainable, superior to the competition, and applicable to multiple situations. For a small or medium business a nice alternative is a MSP or a Managed Service Provider such as Virtual IT Solution, This is a cost effective solution compared to paying for IT staff or local technicians. Other examples of company characteristics that could constitute a sustainable competitive advantage include: superior product quality, extensive distribution contracts, accumulated brand equity and positive company reputation, low cost production techniques, patents and copyrights, government protected monopoly, and superior employees and management team. The list of potential sustainable competitive advantage characteristics is very long. However, some experts hold that in today's changing and competitive world, no advantage can be sustained in the long run. They argue that the only truly sustainable competitive advantage is to build an organisation that is so alert and so agile that it will always be able to find an advantage, no matter what changes occur.

3) Information systems often support and occasionally constitute these competitive advantages. The rapid change has made access to timely and current information critical in a competitive environment. Information systems, like business environmental scanning systems, support almost all sustainable competitive advantages. Occasionally, the information system itself is the competitive advantage. One example is Wal-Mart. They used an extranet to integrate their whole supply chain. This use of information systems gave Sam Walton a competitive advantage for two decades. Another example is Dell Computer. They used the Internet to market custom assembled PCs. Michael Dell is still benefiting from this low-cost promotion and distribution technique. Other examples are eBay, Amazon.com, Federal Express, and Business Workflow Analysis.

The performance monitoring role

MIS are not just statistics and data analysis. They have to be used as an MBO (Management by objectives) tool. They help:

- To establish relevant and measurable objectives
- To monitor results and performances (reach ratios)
- To send alerts, in some cases daily, to managers at each level of the organisation, on all deviations between results and pre-established objectives and budgets.

Check Your Progress 1

1) Answer the following:

   i) Define Management systems and list any five management systems.
   ……
   ……
   ……
   ……

   ii) Which are the three levels of analysis for which Information systems can support a company’s competitive positioning? Explain these briefly.
   ……
   ……
   ……
   ……

2) Indicate True / False.

   i) The functional support role requires the enhanced ability to explore “what if” questions which is central to analysing the likely results of possible decisions and choosing those most likely to shape the future as desired. True ☐ False ☐

   ii) The functional support role requires processing of accounting records into financial statements such as income statements, balance sheets, ledgers, True ☐ False ☐

and management reports, etc.

iii) The decision support role also allows users to deal with contingencies. True ☐ False ☐

iv) The performance monitoring role help to establish relevant and measurable objectives. True ☐ False ☐

v) Management systems are the formal, observable ways in which an organisation administers its operations. True ☐ False ☐

3.4 LEVELS OF MANAGEMENT ACTIVITIES

At different levels of Management, different Information systems are required to support the types of decisions of the organisational hierarchy. While operational managers mostly make structured decisions, senior managers deal with unstructured decisions; middle managers are often faced with semi-structured decisions.

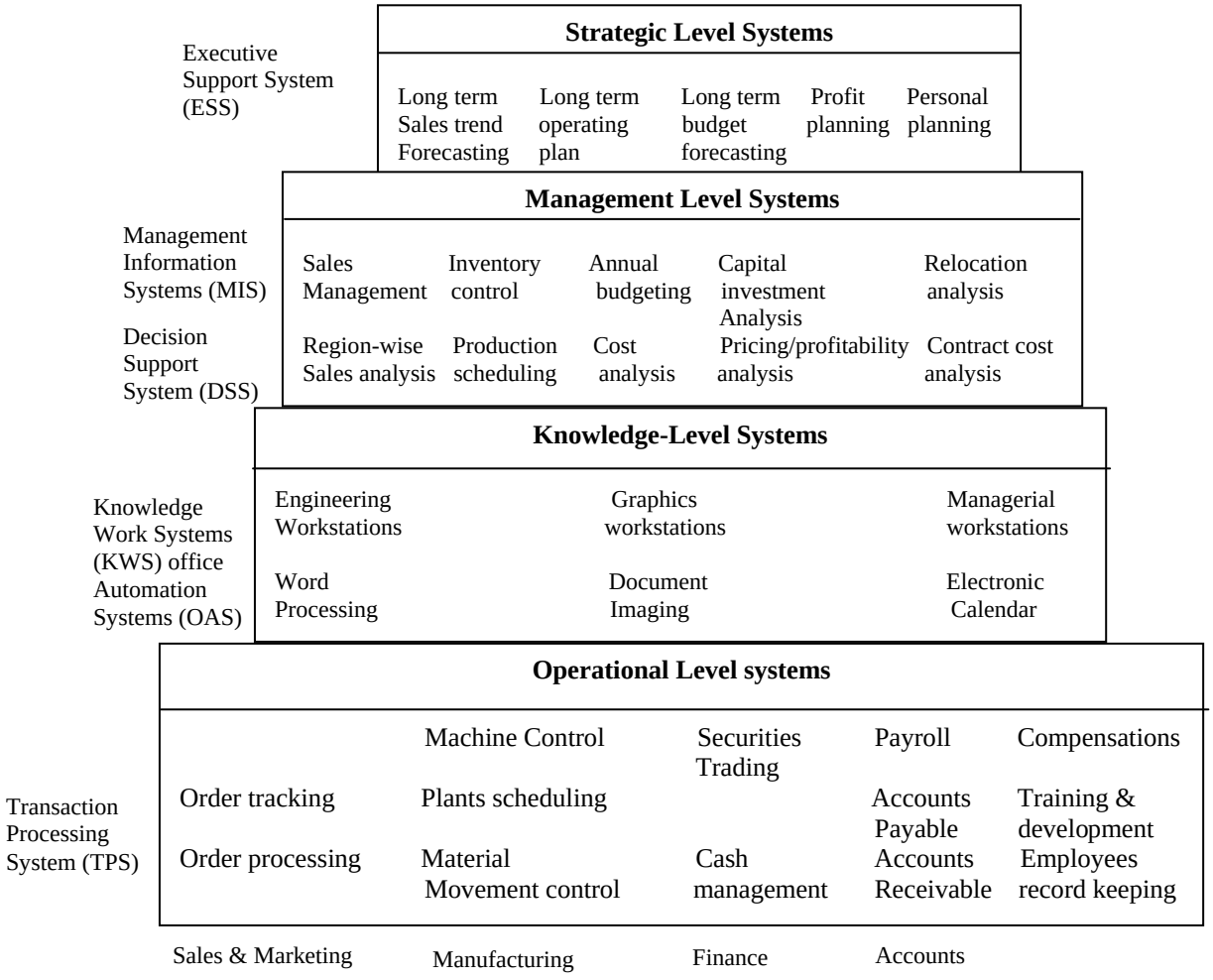

Figure 1: Types of systems

For each functional area in the organisation, four levels of organisational hierarchy can be identified: the operational level, knowledge level, management level and strategic level. Each of these levels is served by different types of information systems as shown above in *Figure 1*. Organisations have transaction processing systems (TPS) at the operational level; knowledge work systems (KWS) and office automation systems (OAS) at the knowledge level; management information systems (MIS) and decision-support systems (DSS) at the management level; and executive support systems (ESS) at the strategic level. Each of the major functional areas of sales and marketing, manufacturing, finance, accounting, and human resources, in turn is served by specialised Systems at each level.

The typical features of these six types of information systems are summarized in

Table 1. It should be noted that each of the different kinds of systems might have components that are used by organisational levels and groups other than their main constituencies; for example; a middle manager may need to extract data from a TPS.

Table 1: Features of the six types of information systems

Type of System	Information Inputs	Processing	Information Outputs	Users
ESS	Aggregate data; external, internal	Graphics; simulations; interactive	Projections; responses to queries	Senior managers
DSS	Low-volume data or massive databases optimised for data analysis; analytic models and data analysis tools	Interactive; simulations analysis;	Special reports; decision analyses; responses to queries	Professionals; staff managers
MIS	Summary transaction data; high- volume data; simple models	Routine reports; simple models; low-level analysis	Summary and exception reports	Middle managers
KWS	Design specifications; knowledge-base	Modeling; simulations	Models; graphics	Professionals; technical staff
Office systems	Documents; schedules	Document management; scheduling; communication	Documents; schedules; mail	Clerical workers
TPS	Transactions; events	Sorting; listing; merging; updating	Detailed reports; lists; summaries	Operations personnel; supervisors

3.4.1 Transaction Processing Systems (TPS)

TPS record daily routine transactions such as sales orders from customers, or bank deposits and withdrawals. TPS are vital for the organisation, as they gather all the input necessary for other types of systems. Think about how one could generate a monthly sales report for middle management or critical marketing information to senior managers without TPS. TPS provide the basic input to the company's database. A failure in the TPS often means disaster for the organisation. Imagine what happens when the reservation system at Air India fails: all operations stop, no transactions can be carried out until the system is up again. Long queues form in front of ATMs and tellers when a bank's TPS crashes.

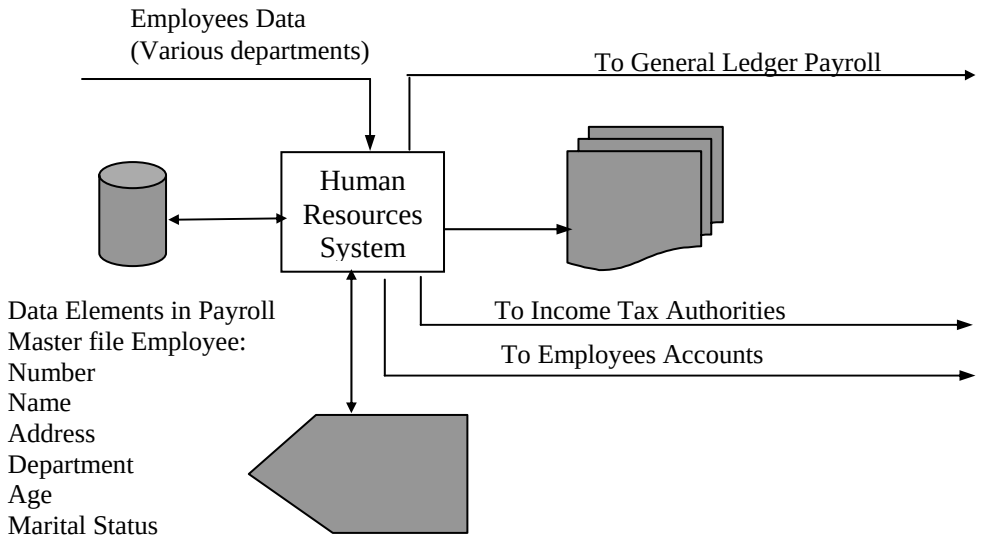

Figure 2: Payroll System (TPS) — a Symbolic Representation

At the operational level, tasks, resources, and goals are predefined and highly structured. The decision to grant credit to a customer, for instance, is made by a lower-level supervisor according to predefined criteria. All that must be determined is whether the customer meets the criteria.

Payroll processing is a typical TPS by HR or Finance and Accounts department and is required by almost all firms. A payroll system keeps track of the money paid to employees. The master file is composed of several pieces of information (such as a name, address, or employee number) called data elements. Data are keyed into the system, updating the data elements. The elements on the master file are combined in different ways to create reports of interest to management and Tax / PF Authorities and to send paychecks to employees. These TPS can generate other report combinations of existing data elements. A typical pay processing is shown in *Figure 2* above.

Typical TPS applications for five functions that is for sales/ marketing, manufacturing / production, finance/ accounting, human resources are shown in *Table 2*:

Table 2: Types of Transaction Processing Systems

	Marketing System	Manufacturing / Production system	Finance / Accounting system	Human Resource system	Other types (Institutes)
Major Functions of Systems	Sales Management	Scheduling	Budgeting	Personnel records	Course records
	Sales Promotion	Purchasing	Billing	Perks	Admissions
	Market Research	Shipping/ Receiving	General ledger	Pay scales	Grade records
	New products	Operations	Cost accounting	Labour relations	Alumni
	Pricing	Engineering		Training	
Major Application Systems	Sales order information system	Machine Control system	Accounts receivable/payable	Leave Record system	Registration system
	Sales commission system	Quality control system	Machine Control system	Payroll	Curriculum control
	Market research system	Purchase order system	Quality control system	Training Details	Classes time table
	Warehousing		Machine Control system	Career Path details	Faculty occupancy

Table 2 Typical applications of TPS. There are five functional categories of TPS: sales/marketing, manufacturing/production, finance/accounting, human resources, and other types of systems specific to a particular industry. Within each of these major functions are sub-functions. For each of these sub-functions (e.g., sales management) there is a major application system.

Managers need TPS to monitor the status of internal operations and the firm's relations with the external environment. TPS are also major producers of information for the other types of systems. Failure of a TPS will lead to the failure of IS of an organisation. (For example, the payroll system illustrated in *Figure 2*, along with other accounting TPS, supplies data to the company's general ledger system, which is responsible for maintaining records of the firm's income and expenses and for producing reports such as income statements and balance sheets).

Features of Transaction Processing Systems

a) Rapid Response

Fast performance with a rapid response time is critical. Businesses cannot afford to have customers waiting for a TPS to respond, the turnaround time from the input of the transaction to the production for the output must be a few seconds or less.

b) Reliability

Many organisations rely heavily on their TPS; a breakdown will disrupt operations or even stop the business. For a TPS to be effective its failure rate must be very low. If a TPS does fail, then quick and accurate recovery must be possible. This makes well–designed backup and recovery procedures essential.

c) Inflexibility

A TPS wants every transaction to be processed in the same way regardless of the user, the customer or the time of day. If a TPS were flexible, there would be too many opportunities for non-standard operations, for example, a commercial airline needs to consistently accept airline reservations from a range of travel agents, accepting different transactions data from different travel agents would be a problem.

(d) Controlled processing

The processing in a TPS must support an organisation's operations. For example if an organisation allocates roles and responsibilities to particular employees, then the TPS should enforce and maintain this requirement.

e) ACID Test Properties

i) **Atomicity:** A transaction's changes to the state are atomic: either all happen or none happen. These changes include database changes, messages, and actions on transducers.

ii) **Consistency:** A transaction is a correct transformation of the state. The actions taken as a group do not violate any of the integrity constraints associated with the state. This requires that the transaction be a correct program.

iii) **Isolation:** Even though transactions execute concurrently, it appears to each transaction T, that others executed either before T or after T, but not both.

iv) **Durability:** Once a transaction completes successfully (commits), its changes to the state survive failures.

3.4.2 Knowledge Work Systems (KWS)

Knowledge Work Systems (KWS) support highly skilled knowledge workers in the creation and integration of new knowledge into the company. Computer Aided Design (CAD) systems used by product designers not only allow them to easily make modifications without having to redraw the entire object (just like word processors for documents), but also enable them to test the product without having to build physical prototypes. Three dimensional graphical simulation systems like GRASP (Graphical Robotics Applications Simulation Package) are used by British Aerospace and Rolls Royce for evaluating and programming industrial robots. Architects use CAD software to create, modify, evaluate and test their designs; such systems can generate photorealistic pictures, simulating the lighting in rooms at different times of the day, perform calculations, for instance on the amount of paint required. Surgeons use sophisticated CAD systems to design operations.

Financial institutions are using knowledge work systems to support trading and portfolio management with powerful high-end PCs. These allow managers to get instantaneous analysed results on huge amounts of financial data and provide access to external databases.

Knowledge work systems (KWS) and office systems serve the information needs at the knowledge level of the organisation. Knowledge work systems aid knowledge workers, whereas office automation systems primarily aid data workers (although they are also used extensively by knowledge workers).

In general, *knowledge workers* are people who hold formal university degrees and who are often members of a recognized profession, such as engineers, doctors, lawyers, and scientists. Their jobs consist primarily of creating new information and knowledge. Knowledge work systems (KWS), such as scientific or engineering design workstations, promote the creation of new knowledge and ensure that new knowledge and technical expertise are properly integrated into the business. *Data workers* typically have less formal, advanced educational degrees and tend to process rather than create information. They consist primarily of secretaries, accountants, filing clerks, or managers whose jobs are principally to use, manipulate, or disseminate information. Office systems are information technology applications designed to increase data workers' productivity by supporting the coordinating and communicating activities of the typical office. Office systems coordinate diverse information workers, geographic units, and functional areas: The systems communicate with customers, suppliers, and other organisations outside the firm and serve as a clearinghouse for information and knowledge flows.

3.4.3 Office Automation System (OAS)

Office Systems or Office Automation Systems (OAS) support general office work for handling and managing documents and facilitating communication. Text and image

processing systems evolved from word processors to desktop publishing, enabling the creation of professional documents with graphics and special layout features. Spreadsheets, presentation packages like PowerPoint, personal database systems and note-taking systems (appointment book, notepad, card file) are part of OAS.

In addition OAS include communication systems for transmitting messages and documents (*e-mail*) and teleconferencing capabilities.

3.4.4 Management Information Systems

Management Information Systems (MIS) generate information for monitoring performance (e.g., productivity information) and maintaining coordination (e.g., between purchasing and accounts payable).

MIS extract process and summarise data from the TPS and provide periodic (weekly, monthly, quarterly) reports to managers.

Today MIS are becoming more flexible by providing access to information whenever needed (rather than prespecified reports on a periodic basis). Users can often generate more customized reports by selecting subsets of data (such as listing the products with 2% increase in sales over the past month), using different sorting options (by sales region, by salesperson, by highest volume of sales) and different display choices (graphical, tabular).

Management information systems can be defined as the study of information systems in business and management. The term *management information systems (MIS)* also designates a specific category of information systems serving management-level functions. Management information systems (MIS) serve the management level of the organisation, providing managers with reports and, in some cases, with on-line access to the organisation’s current performance and historical records. Typically, they are oriented almost exclusively to internal, not environmental or external, events. MIS primarily serve the functions of planning, controlling, and decision making at the management level. Generally, they depend on underlying transaction processing systems for their data.

MIS summarize and report on the company’s basic operations. The basic transaction data from TPS are compressed and are usually presented in long reports that are produced on a regular schedule. *Figure 3* shows how a typical MIS transforms transaction-level data from inventory, production, and accounting into MIS files that are used to provide managers with reports. *Table 3* shows a sample report from this system.

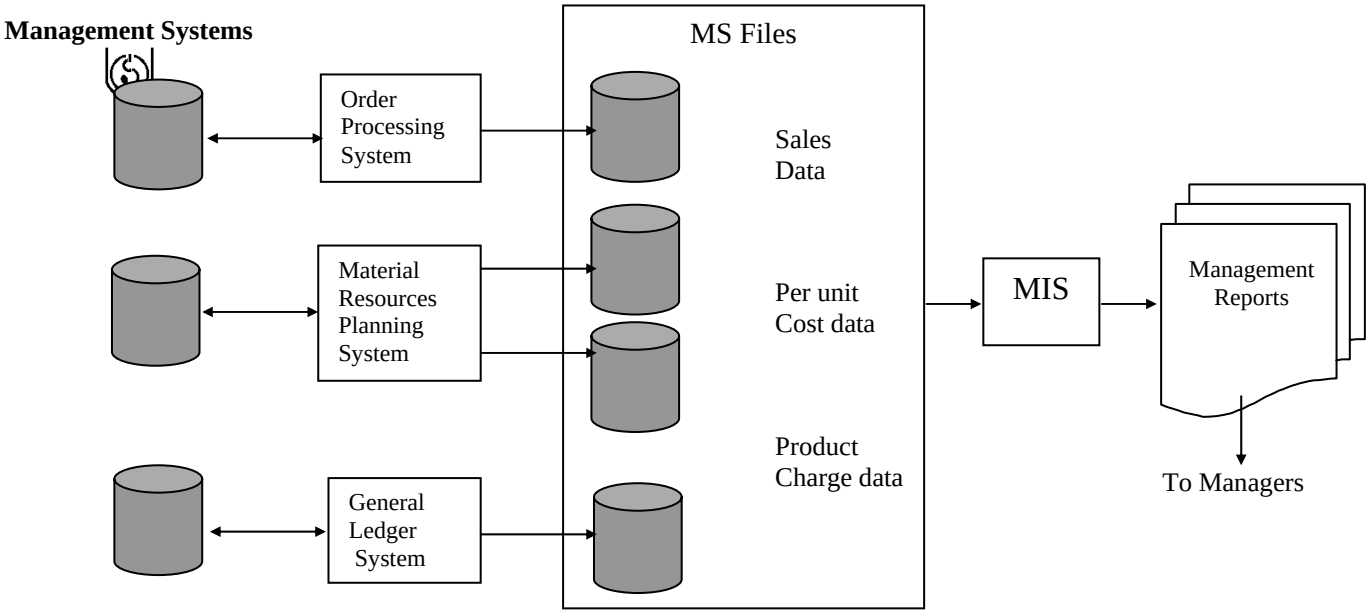

Figure 3: This diagram illustrates how management information systems obtain their data from the organisation's TPS. In this system, three TPS supply summarise transaction data at the end of the time period to the MIS reporting system. Managers obtain the organisational data through the MIS, which provides them with the appropriate reports.

Table 3: A Sample Report that Might be Produced by the MIS of Figure 3

PRODUCT CODE	PRODUCT DESCRIPTION	SALES REGION	ACTUAL SALES	PLANNED	ACTUAL VS PLANNED
4469	Carpet Cleaner	Northeast	4.066.700	4.800.000	0.85
		South	3.778.112	3.750.000	1.01
		Midwest	4.867.001	4.600.000	1.06
		West	4.003.440	4.400.000	0.91
	TOTAL		16.715.253	17.550.000	0.95
5674	Room Freshener	Northeast	3.676.700	3.900.000	0.94
		South	5.608.112	4.700.000	1.19
		Midwest	4.711.001	4.200.000	1.12
		West	4.563.440	4.900.000	0.93
	TOTAL		18.559.253	17.700.000	1.05

Another example of MIS is available from the sales TPS wherein transaction data (name of salesperson, customer name and address, name and quantity of item sold, line sales amount, total sales amount, form of payment) are stored on every sale made. The MIS then generates reports (the frequency of the report being specified by users) such as:

- total sales for each item
- total sales for region
- sales for each salesperson.

MIS reports can be classified by content or time. In terms of content, reports may be comprehensive (listing each sales transaction over a specified period in a given sales region), summary (showing the total sales of each item sold in a given region) or exception reports (listing items that have shown a drop in sales by over 20% in a given region since the last period).

In terms of time, MIS produce historical reports (comparing past sales information with the present); status reports (only showing current sales); and predictive reports (forecasts of next months sales).

MIS are not just statistics and data analysis, but also assessment of human capabilities. They have to be used as an MBO (Management by objectives) tool. They help:

- to establish relevant and measurable objectives

- to monitor results and performances (reach ratios)
- to send alerts, in some cases daily, to managers at each level of the organisation, on all deviations between results and pre-established objectives and budgets.

3.4.5 Decision-Support Systems

Decision-support systems (DSS) also serve the management level of the organisation. DSS help managers make decisions that are unique, rapidly changing, and not easily specified in advance. They address problems where the procedure for arriving at a solution may not be fully predefined in advance. Although DSS use internal information from TPS and MIS, they often bring in information from external sources, such as current stock prices or product prices of competitors.

Clearly, by design, DSS have more analytical power than other systems. They are built explicitly with a variety of models to analyse data, or they condense large amounts of data into a form where they can be analysed by decision makers. DSS are designed so that users can work with them directly; these systems explicitly include user-friendly software. DSS are interactive; the user can change assumptions, ask new questions, and include new data.

As mentioned above, there are theoretical possibilities of building such systems in any knowledge domain. One example is the 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 an organisation finds its necessity. 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.

A very useful, small, but powerful DSS is the voyage-estimating system of a company that exists primarily to carry bulk cargoes of coal, oil, ores, and finished products for another company with which it has a long term contract. The firm owns some vessels, charters others, and bids for shipping contracts in the open market to carry general cargo. A voyage-estimating system calculates financial and technical voyage details. Financial calculations include ship/time costs (fuel, labour, capital), freight rates for various types of cargo, and port expenses. Technical details include a myriad of factors such as ship cargo capacity, speed, port distances, fuel and water consumption, and loading patterns (location of cargo for different ports). The system can answer questions such as the following: Given a customer delivery schedule and an offered freight rate, which vessel should be assigned at what rate to maximize profits? What is the optimum speed at which a particular vessel can optimize its profit and still meet its delivery schedule? What is the optimal loading pattern for a ship bound for Mumbai from London? *Figure 4* illustrates the DSS built for this company. The system operates on a powerful desktop personal computer, providing a system of menus that makes it easy for users to enter data or obtain information

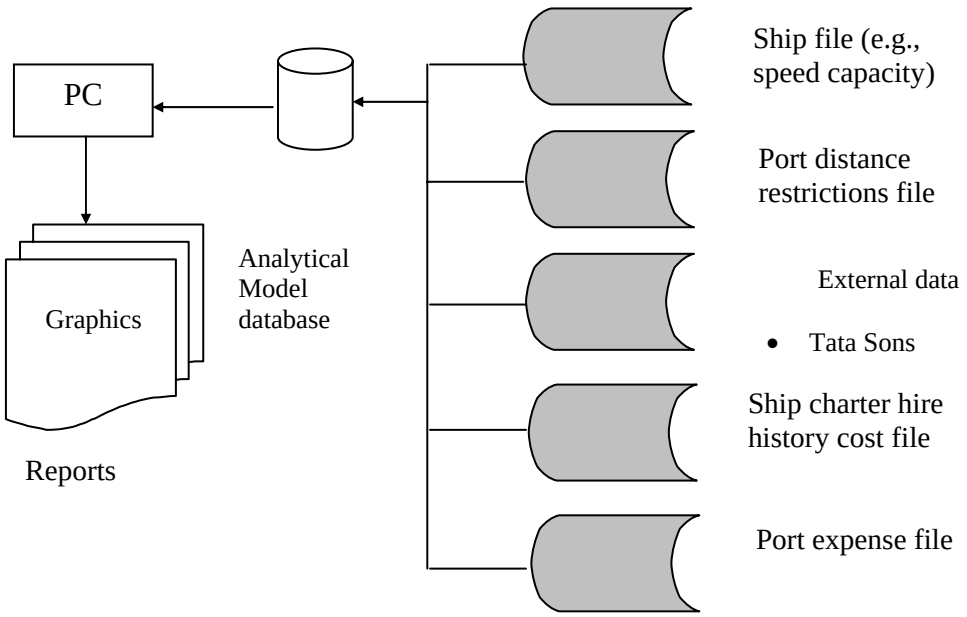

Figure 4: Decision support system for voyage estimation

3.4.6 Executive Support Systems (ESS)

Senior managers use executive support systems (ESS) to make decisions. ESS serves the strategic level of the organisation. They address non-routine decisions requiring judgment, evaluation, and insight because there is no agreed-on procedure for arriving at a solution. ESS creates a generalised computing and communications environment rather than providing any fixed application or specific capability. ESS is designed to incorporate data about external events such as new tax laws or competitors, but they also draw summarized information from internal MIS and DSS. They filter, compress, and track critical data, emphasizing the reduction of time and effort required to obtain information useful to executives. ESS employ the most advanced graphics software and can deliver graphs and data from many sources immediately to a senior executive's office or to a boardroom.

Unlike the other types of information systems, ESS is not designed primarily to solve specific problems. Instead, ESS provides a generalised computing and telecommunications capacity that can be applied to a changing array of problems. Whereas many DSS are designed to be highly analytical, ESS tends to make less use of analytical models.

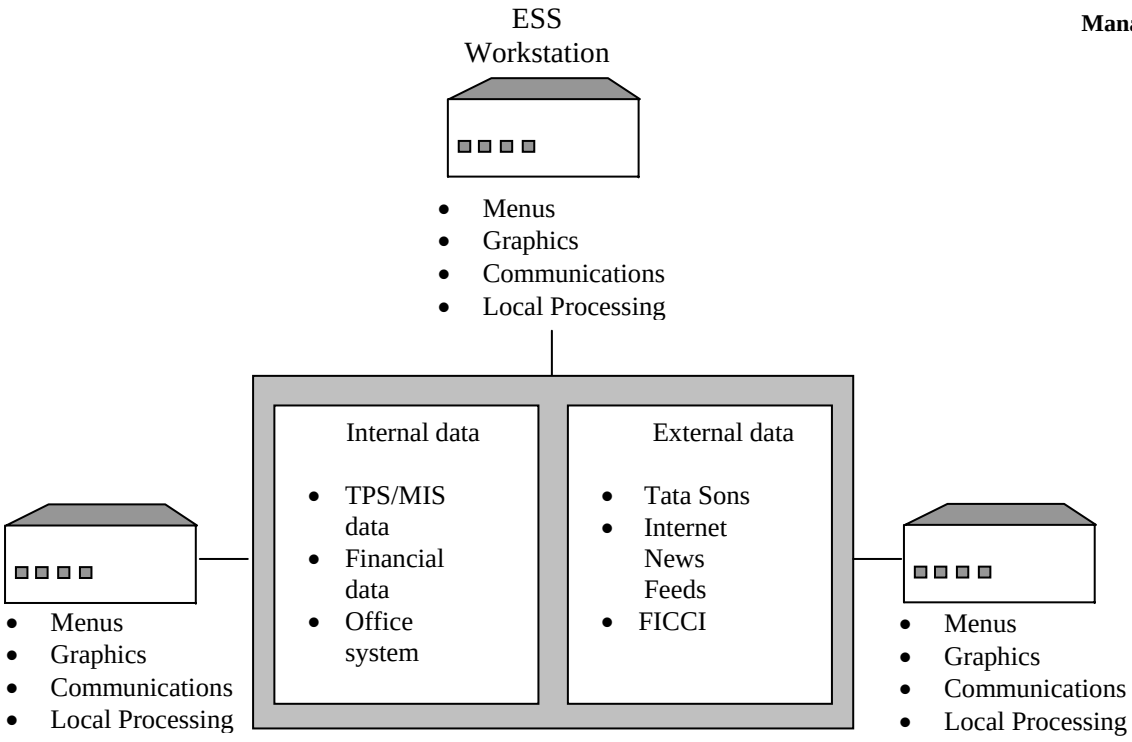

Figure 5: Executive support system

Questions ESS assists in answering include the following: In what business should we be? What are the competitors doing? What new acquisitions would protect us from cyclical business swings? Which units should we sell to raise cash for acquisitions? *Figure 5* illustrates a model of an ESS. It consists of workstations with menus, interactive graphics, and communications capabilities that can access historical and competitive data from internal corporate systems and external databases such as Dow Jones News/Retrieval or the Gallup Poll. Because ESS are designed to be used by senior managers who often have little, if any, direct contact or experience with computer-based information systems, they incorporate easy-to-use graphic interfaces.

Relationship of Systems to one Another

Different types of systems exist in organisations. Not all organisations have all of the types of systems described in this unit. Many organisations may not have knowledge work systems, executive support systems or decision support systems. But today most organisations make use of office automation systems and have a portfolio of information system applications based on TPS and MIS (marketing systems, manufacturing systems, human resource systems). Some organisations have hybrid information systems that contain some of the characteristics of different types of systems.

The field of information systems is moving so quickly that the features of one particular type of system are integrated to other types (e.g., MIS having many of the features of ESS). System characteristics evolve and new types of systems emerge. Yet the classification of information systems into these different types is useful because each type of system has certain features that are relevant in particular situations.

Figure 6 illustrates how the systems serving different levels in the organisation are related to one another. TPS are typically a major source of data for other systems, whereas ESS is primarily a recipient of data from lower-level systems. The other types of systems may exchange data with each other as well. Data may also be exchanged among systems serving different functional areas. For example, an order captured by a sales system may be transmitted to a manufacturing system as a transaction for producing or delivering the product specified in the order.

It is definitely advantageous to have some measure of integration among these systems so that information can flow easily between different parts of the organisation. But integration costs money, and integrating many different systems is extremely time consuming and complex. Each organisation must weigh its needs for integrating systems against the difficulties of mounting a large-scale systems integration effort.

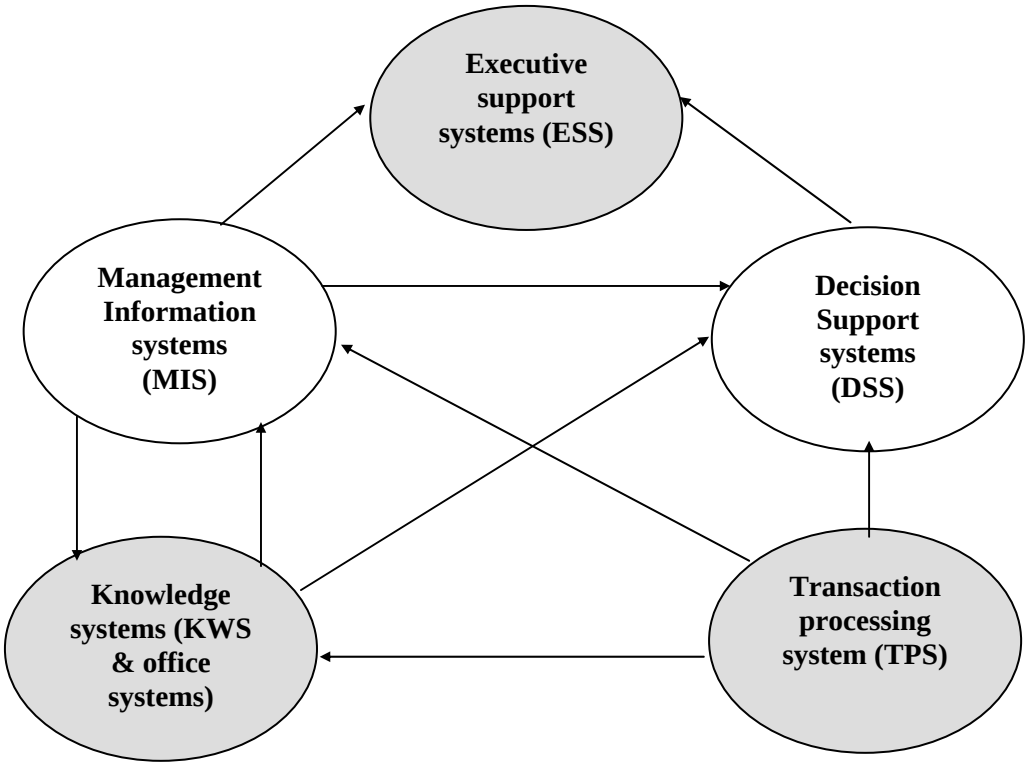

Figure 6: Inter-relationship

Check Your Progress 2

1) Answer the following:

   i) Associate the six kinds of information systems with the groups served.
   ……
   ……..
   …….

   ii) Identify the five functional categories of TPS.
   ……
   ……
   ……

2) Mark the correct answer:

   a) Information systems that monitor the elementary activities and transactions of the organisations are:

      i) Management-level systems.
      ii) Operational-level systems.
      iii) Knowledge-level systems.
      iv) Strategic-level systems.

   b) Projections and responses to queries are information output characteristics associated with:

      i) DSS
      ii) MIS

iii) ESS
iv) TPS

c) Summary transaction data, high-volume data, and simple models are information inputs characteristic of

i) DSS ☐
ii) MIS ☐
iii) ESS ☐
iv) TPS ☐

d) Which of the following individuals typically have less formal, advanced educational degrees and tend to process rather than create information?

i) knowledge workers ☐
ii) executives ☐
iii) systems analysts ☐
iv) data workers ☐

e) Management information systems usually:

i) serve managers interested in weekly, monthly, and yearly results, not day-to-day activities.
ii) help managers make decisions that are unique, rapidly changing, and not easily specified in advance. ☐
iii) provide managers with a generalized computing and telecommunications capacity that can be applied to a changing array of problems. ☐
iv) perform and record the daily routine transactions necessary to the conduct of business. ☐

f) Decision support systems usually:

i) serve managers interested in weekly, monthly, and yearly results, not day-to-day
ii) activities. ☐
iii) help managers make decisions that are unique, rapidly changing, and not easily specified in advance. ☐
iv) provide managers with a generalised computing and telecommunications capacity that can be applied to a changing array of problems. ☐
v) perform and record the daily routine transactions necessary to the conduct of business.

g) Identifying customers and markets using data on demographics, markets, consumer behaviour, and trends is an example of

i) operational-level sales and marketing information system. ☐
ii) knowledge-level sales and marketing information system. ☐
iii) management-level sales and marketing information system. ☐
iv) strategic-level sales and marketing information system. ☐

3.5 SUMMARY

With this unit, we complete our discussion on various roles a manger has to play and how information systems can assist him/has in for these roles. In this unit you have also learned that depending upon the position / level in the hierarchy, a manager has to carry out strategic, managerial or operational responsibilities and there are appropriate information systems for these levels. Decision support and strategic support information systems have very large scope for implementation in various organisations. Students therefore, must further study case studies in these areas.

3.6 SOLUTIONS / ANSWERS

Check Your Progress 1

i) Management systems can be defined as formal, observable ways in which an organisation administers its operations. A management system provides the framework of processes and procedures used to ensure that the organisation can fulfill all tasks required to achieve its objectives. Five management systems are listed below:

- Change management system
- Cost management system
- Crisis management system
- Facility management system
- Knowledge management system

ii) The three levels of analysis in which Information systems can support, a company's competitive positioning are: (a) Internal Business Management Systems, (b) Company's Core competence, and (c) Competitive environment Information systems.

a) Internal Business Management Systems: These systems provide the solutions for reduction of costs and for enhancement of management of performance. Control over piloting the set functions of the company can be carried out, by using these systems. The system output provides evaluation and qualitative reports.

b) Company's Core competence: To ensure that a company's core competency remains in an advantageous position / sustainable it must be difficult to mimic, unique, sustainable, superior to the competition, and applicable to multiple situations. This advantage could come from superior product quality, extensive distribution contracts, accumulated brand equity and positive company reputation, low cost production techniques, patents and copyrights, government protected monopoly, and superior employees and management team. In today's changing and competitive world the only truly sustainable competitive advantage is to build an organisation backed by an information system, that is so alert and so agile that it will always be able to find an advantage, no matter what changes occur.

c) Competitive environment Information systems: These are the Information systems which provide business environmental scanning, and implementation of business processes to ensure competitive advantages. These systems need to provide access to timely and current information critical in a competitive environment.

2) True / False.

i) False, ii) True, iii) True, iv) True, v) True.

Check Your Progress 2

1) Answers:

a) Six kinds of information systems with the particular groups served are as shown below:

Sl. No.	Information System	Group served
1	Executive Support System (ESS)	Top / Strategic level managers
2	Management Information System (MIS)	Managers
3	Decision Support System (DSS)	Managers / Professionals
4	Knowledge Work System (KWS)	Professionals / Technical Staff
5	Office Information System (OIS)	Clerical workers
6	Transaction Processing Systems (TPS)	Jr. Managers / Operational supervisors

b) Five functional categories of TPS are:

i) Sales / Marketing
ii) Manufacturing / Production
iii) Finance / Accounts
iv) Human Resource
v) Other types – specific to particular industry; for example, Materials Management for manufacturing industry.

2) Mark the correct answer:

a) Information systems that monitor the elementary activities and transactions of the organisations are:

i) Management-level systems.
ii) Operational-level systems.
iii) Knowledge-level systems.
iv) Strategic-level systems. Y

b) Projections and responses to queries are information output characteristics associated with :

i) DSS Y
ii) MIS
iii) ESS
iv) TPS

c) Summary transaction data, high-volume data, and simple models are information inputs characteristic of

i) DSS
ii) MIS Y
iii) ESS
iv) TPS

d) Which of the following individuals typically have less formal, advanced educational degrees and tend to process rather than create information?

i) knowledge workers
ii) executives
iii) systems analysts
iv) data workers Y

e) Management information systems usually:

i) serve managers interested in weekly, monthly, and yearly results, not day-to-day activities.
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iii) provide managers with a generalized computing and telecommunications capacity that can be applied to a changing array of problems.
iv) perform and record the daily routine transactions necessary to the conduct of business.

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f) Decision support systems usually:

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iii) help managers make decisions that are unique, rapidly changing, and not easily specified in advance.
iv) provide managers with a generalised computing and telecommunications capacity that can be applied to a changing array of problems.
v) perform and record the daily routine transactions necessary to the conduct of business.

Y

g) Identifying customers and markets using data on demographics, markets, consumer behavior, and trends is an example of

i) operational-level sales and marketing information system.
ii) knowledge-level sales and marketing information system.
iii) management-level sales and marketing information system.
iv) strategic-level sales and marketing information system.

Y

3.7 FURTHER READINGS/REFERENCES

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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*)

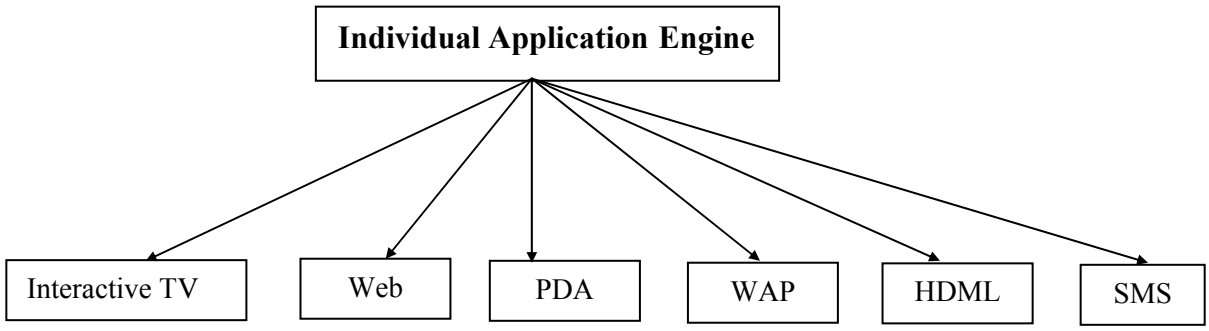

Figure 1: Various information communication devices

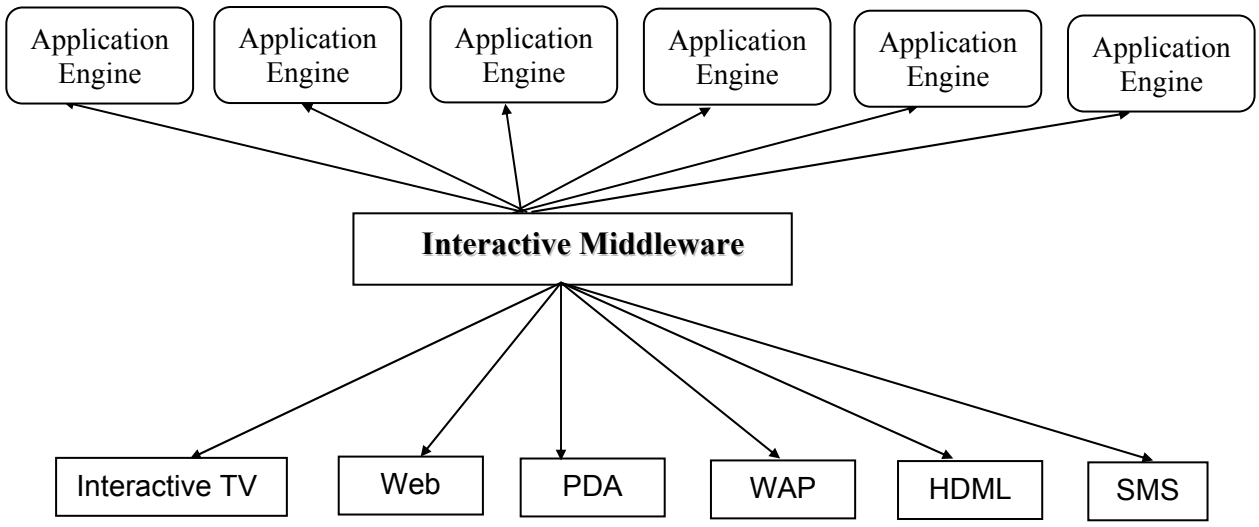

Figure 2: Convergence of various communications devices

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 *s*tudies 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.

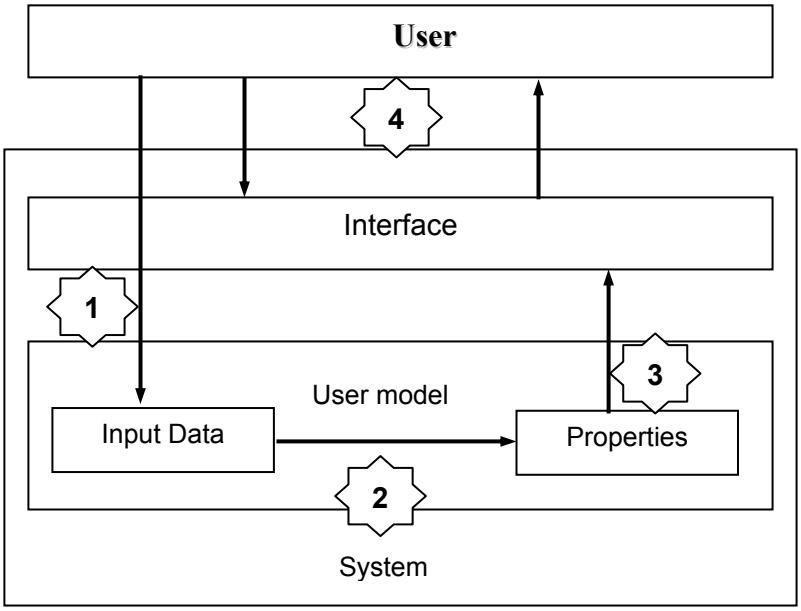

Figure 3: Four layers for the evaluation of adaptive systems

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.

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

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*.

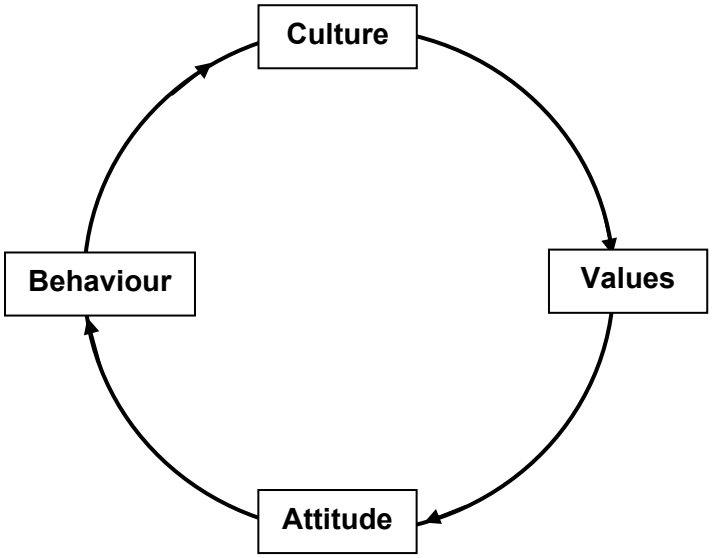

Figure 4: The Influence of culture on behaviours

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.

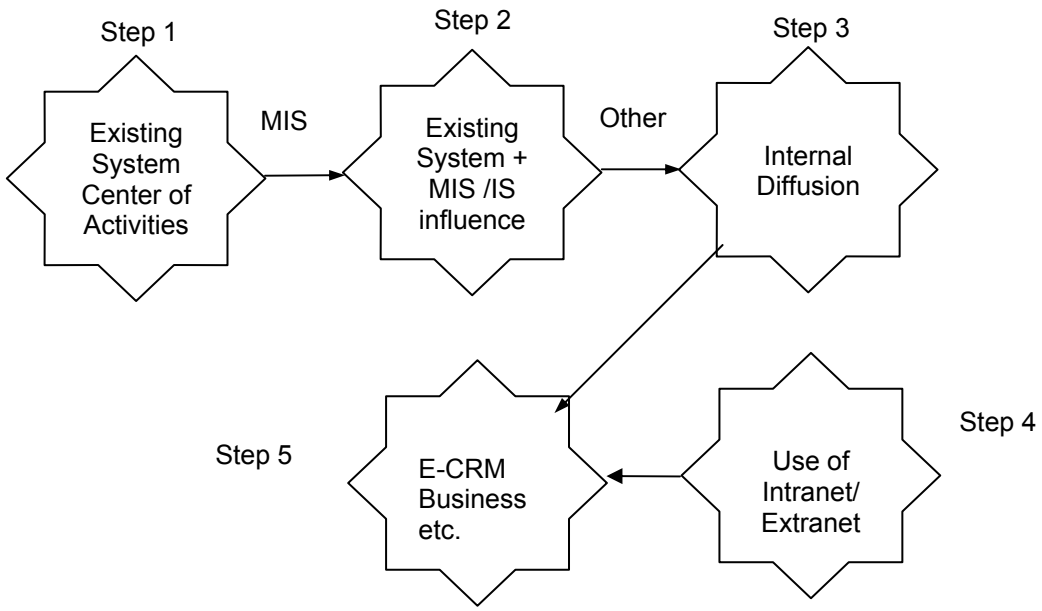

Figure 5: Information flow and adoption

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.

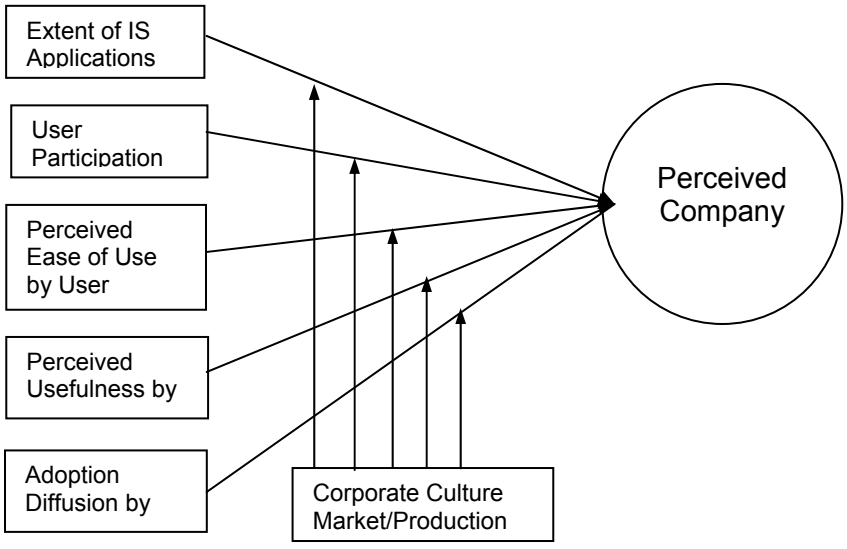

Figure 6: Impact of corporate culture on information system

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:
  - The investment decision
  - The financing decision
  - The dividend decision
  - Working capital management decisions.
- Cost-benefit analysis — process of weighing the total expected costs *vs*. the total expected benefits.
- Decision trees
  - Program Evaluation and Review Technique (PERT)
  - Critical path analysis
  - 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
  - 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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