SIR C R REDDY COLLEGE OF ENGINEERING

Department of Information Technology

MANAGEMENT INFORMATION SYSTEM

4_2 SEMESTER

Prepared by

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UNIT-I
Information System And Organization
Role of Information Systems in an Organization:

Any business, big or small, must have a system in place to collect, process, store and share data. In the past, these tasks required a lot of time and paperwork. Today, companies use modern technology to streamline and automate these operations. Information systems are now playing a crucial role in data processing and decision making. When used correctly, they can positively impact an organization's overall performance and revenue

What Is an Information System?

At the most basic level, an information system (IS) is a set of components that work together to manage data processing and storage. Its role is to support the key aspects of running an organization, such as communication, record-keeping, decision making, data analysis and more. Companies use this information to improve their business operations, make strategic decisions and gain a competitive edge.

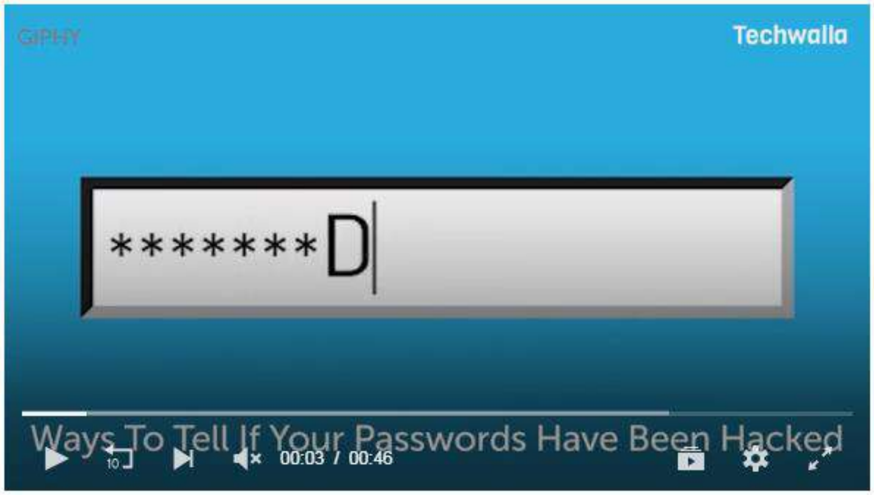
Information systems typically include a combination of software, hardware and telecommunication networks. For example, an organization may use customer relationship management systems to gain a better understanding of its target audience, acquire new customers and retain existing clients. This technology allows companies to gather and analyze sales activity data, define the exact target group of a marketing campaign and measure customer satisfaction.

The Benefits of Information Systems

Modern technology can significantly boost your company's performance and productivity. Information systems are no exception. Organizations worldwide rely on them to research and develop new ways to generate revenue, engage customers and streamline time-consuming tasks.

With an information system, businesses can save time and money while making smarter decisions. A company's internal departments, such as marketing and sales, can communicate better and share information more easily.

Since this technology is automated and uses complex algorithms, it reduces human error. Furthermore, employees can focus on the core aspects of a business rather than spending hours collecting data, filling out paperwork and doing manual analysis.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Ways To Tell If Your Passwords Have Been Hacked
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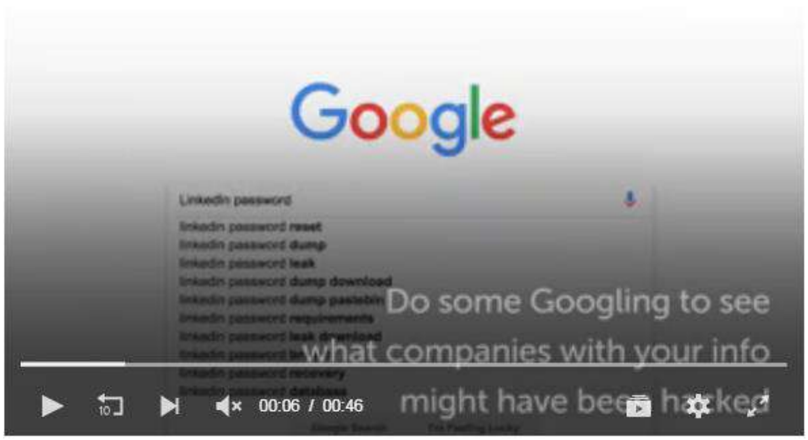

Google
Linkedin password
Do some Googling to see what companies with your info might have been hacked
00:06 / 00:46


Techwalla
But, if you were hacked...
00:17 / 00:46

Uses and Applications

There are different types of information systems and each has a different role. Business intelligence (BI) systems, for instance, can turn data into valuable insights.

This kind of technology allows for faster, more accurate reporting, better business decisions and more efficient resource allocation. Another major benefit is data visualization, which enables analysts to interpret large amounts of information, predict future events and find patterns in historical data.

Organizations can also use enterprise resource planning (ERP) software to collect, manage and analyze data across different areas, from manufacturing to finance and accounting. This type of information system consists of multiple applications that provide a 360-degree view of business operations. NetSuite ERP, PeopleSoft, Odoo and Intacct are just a few examples of ERP software.

Like other information systems, ERP provides actionable insights and helps you decide on the next steps. It also makes it easier to achieve regulatory compliance, increase data security and share information between departments. Additionally, it helps to ensure that all of your financial records are accurate and up-to-date.

In the long run, ERP software can reduce operational costs, improve collaboration and boost your revenue. Nearly half of the companies that implement this system report major benefits within six months.

At the end of the day, information systems can give you a competitive advantage and provide the data you need to make faster, smarter business decisions. Depending on your needs, you can opt for transaction processing systems, knowledge management systems, decision support systems and more. When choosing one, consider your budget, industry and business size. Look for an information system that aligns with your goals and can streamline your day-to-day operations.

Matching The Information System Plan To The Organizational Strategic Plan

Planning for the information systems in an organization generally has not been closely related to the overall strategic planning processes through which the organization prepares for its future. An M/S strategic planning process is conceptualized and illustrated as one which /inks the. organization’s "strategy set" tb an MIS "strategy set. "

The literature of management information systems (MIS) concentrates largely on the nature and structure of MIS’s and on processes for designing and developing such systems. The idea of "planning for the MIS" is usually treated as either one of developing the need and the general design concept for such a system, or in the context of project planning for the MIS development effort. However, strategic planning for the informational needs of the organization is both feasible and necessary if the MIS is to support the basic purposes and goals of the organization. Indeed, one of the possible explanations [6] for the failure of many MIS’s i~-that they have been designed from the same "bottom up" point of view that characterized the development of the data processing systems of an earlier era. Such design approaches primarily reflect the pursuit of efficiency, such as through cost savings, rather than the pursuit of greater organizational effectiveness.1 The modern view of an MIS as an organizational decision support system is inconsistent with the design/development approaches which are appropriate for data processing. The organization’s operating efficiency is but one aspect for consideration in management decision making. The achievement of greater organizational effectiveness is the paramount consideration in most of the management decisions which the MIS is to support; it also must be of paramount importance in the design of the MIS. There is an intrinsic linkage of the decisionsupporting MIS to the organization’s purpose, objectives, and strategy. While.this conclusion may appear to be straightforward, it has not been operationalized as a part of MIS design methodology. There are those who argue that the MIS designer cannot hope to get involved in such things as organizational missions, objectives, and strategies, since they are clearly beyond his domain of authority.

MIS Strategic Planning

An Overview Figure t abstractly shows the overall process for performing MIS strategic planning. This figure shows an "MIS Strategic Planning" process which transforms an "Organizational Strategy Set," made up of organizational mission, objectives, strategy, and other strategic organizational attributes, into an "MIS Strategy Set," made up of system objectives, constraints, and design principles. Figure . 1 describes an information-based approach to strategic planning for the MIS in that it identifies an information set -- the "MIS Strategy Set" -- which will guide the design and development of the MIS. While the elements of this MiS Strategy Set -- system objectives, constraints, and design principles -- are not usually thought of in this context, they are generally recognized to be the guiding considerations in developing the MIS design (e.g., [10]). However well recognized the elements of the MIS Strategy Set are, Figure 1 shows the MrS Strategy Set as emanating directly from another information set, the "Organizational Strategy Set." This direct relationship between the two information sets is neither well recognized nor operationalized. It is this linkage which is the province of MIS Strategic Planning and it is on the operationalizing of the transformation process between these two information sets that this article focuses. It will prove useful to describe both the "Organizational Strategy Set" and the "’MIS Strategy Set" in some detail, before describing an operational process for accomplishing the MIS Strategic Planning function which is described conceptually in Figure 1. The Organizational Strategy Set The "Organizational Strategy Set" is composed of those elements of organizational purpose and direction which are developed as a result of the organization's strategic planning process -- the organization's mission, objectives and strategy -- as well as certain other strategic organizational attributes which are of particular relevance to the MIS.

FIGURE 1. Overall MIS Strategic Planning Process

Since the terminology which is applied to these strategic planning outputs generally varies from company to company and between business firms and public agencies, it is useful to define and illustrate the elements of the organizational strategy set used in this article. No inference should be drawn that these are proposed as the "correct" descriptions, or that the definitions used here are universally appropriate; rather, the delineations are useful for fully developing the MIS Strategic Planning process. The organization's mission The broadest strategic planning which must be done by an organization is that of its mission. An organization's mission statement tells what it is, why it exists, and the unique contribution it can make. The mission answers the organization's basic question, "What business are we in?" Some people consider such questions idle academic nonsense; to them, their mission --the business that they are in m is clear: "We make widgets," or "We run railroads." It became increasingly apparent during the 1960's that such thinking was too limited. Organizations which felt that they knew their business disappeared in vast numbers from the scene. Today's business, however bright its growth prospects may appear, may not exist in its current form in only a few years.

The organization's objectives Once the organization's mission has been determined, its objectives -- desired future positions or "destinations" that it wishes to reach m should be selected. These destinations may be stated in either quantitative or qualitative terms, but they should be broad and timeless statements, as opposed to specific, quantitative goals, or targets. For instance, among the stated objectives of PPG Industries are: "1) . . . to increase earnings per share to attain a continuing return of 14.5%or more on stockholder's equity and to provide consistently increasing dividends [the prime objective]. "2) . . . to employ the least number and highest quality of people necessary to accomplish the prime objective and to provide them with the opportunities to develop and apply their fullest abilities. "3)... to have the company accepted as dynamic, responsible, professionally managed, profit oriented corporation engaged in exciting and important fields of business, with the ability to meet successfully the economic and social challenges of the future."

The organization's strategy

The organization's strategy is the general direction in which it chooses to move in order to achieve its goals and objectives. For instance, one company has stated that it: "... has heavy investment, a good reputation, great skills and experience, a viable organization, and, in some instances, a .special situation in the.., industries." and that it will: "... exploit these strengths and .... not diversify at the present time, into unrelated industries." A more detailed strategy for another firm includes the following: "... increase U.S. market penetration through the development of a regional manufacturing capability and the development of secondary distribution channels." Another company's strategy calls for a: "... low-price, low-cost product achieved through product standardization..." together with: "... the development of new products on a similar basis in a posture of defensive innovation against the technological progress of competitors."

The MIS Strategy Set

The MIS strategy elements, which are the substance of strategic planning for the MIS, are system objectives, system constraints, and system design strategies. System objectives System objectives define the purpose which the MIS is to serve. For instance, system objectives may be stated in terms that are similar to, but much more specific than, organizational objectives -- e.g., "to permit the payment of 98% of invoices by the due date" is a system objective stated in activity terms. Also, system objectives may be stated in direct information and communication terms -- e.g., "to collect, and process all routing and cost information and provide it in a timely fashion to the dispatcher." The most sophisticated variety of system objectives are stated in decision-oriented terms -- e.g., "to permit the determination of the best routing no more than one hour after the tentative routing choice has been implemented."

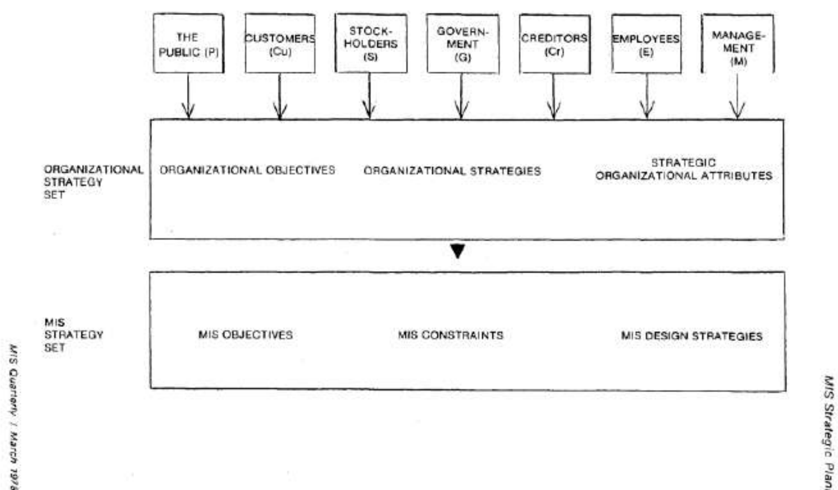


FIGURE1. Overall MIS Strategic Planning Process

ORGANIZATIONAL OBJECTIVES	ORGANIZATIONAL STRATEGIES	STRATEGIC ORGANIZATIONAL ATTRIBUTES
O_1: to increase earnings by 10% per year (S, Cr, M)	S_1: Diversification into new businesses (O_1, O_6)	A_1: highly sophisticated management (M)
O_2: to improve cash flow (G, S, Cr)	S_2: Improvements in credit practices (P_1, O_2, O_3)	A_2: poor recent performance has fostered a recognition of the need for change (S, M)
O_3: to maintain a high level of customer good will (Cu)	S_3: Product redesign (O_3, O_4, O_5)	A_3: most managers are experienced users of computer services (M)
O_4: to be perceived as socially responsible (G, P)		A_4: high degree of decentralization of management authority
O_5: to produce high quality, safe products (Cu, G)		A_5: organization must be responsive to regulatory agencies
O_6: to eliminate vulnerability to the business cycle (S, Cr)		

FIGURE 3. Organizational Strategy Set

MIS OBJECTIVES	MIS CONSTRAINTS	MIS DESIGN STRATEGIES
MO_1: to improve speed of billing (S_2)	C_1: Availability of funds for MIS development may be reduced (A_2)	D_1: Design on modular basis (C_1)
MO_2: to provide information on product failures (S_3)	C_2: System must incorporate best available decision models and management techniques (A_1, A_3)	D_2: Modular design must produce viable system at each stage of completion (C_1)
MO_3: to provide information on new business opportunities (S_1)	C_3: System must incorporate environmental information as well as internal information (MO_2, MO_3, MO_4)	D_3: System must be oriented to differential usage by various classes of managers (A_4, C_4)
MO_4: to provide information which will permit the assessment of the level of organizational objectives (O)	C_4: System must provide for different reports involving various levels of aggregation (A_4)	D_4: System should be responsive to the perceived needs of it's user-managers (A_1, A_3, A_4)
MO_5: to provide timely and accurate information on recent performance (A_2)	C_5: System must be capable of producing information other than management information (MO_6)	D_5: System should have real time inquiry capability (MO_7, O_3) — use COBOL (A_1, A_3)
MO_6: to produce reports desired by regulatory agencies (A_5)		
MO_7: to produce information which will permit quick response to customer inquiries (O_3)		

FIGURE 4. MIS Strategy Set

Strategic planning

A full 56% of the time spent on strategic planning is wasted

Strategic planning is often a disappointment to all involved. The objective sounds simple enough: Define the organization's strategy and make resource allocation decisions to pursue it. The problem is, the results often fail to meet expectations.

Many executives lack a coherent roadmap for creating their strategic plan

Functional leaders can't plan properly if they aren't clear on the enterprise and business mission, vision and objectives. And they can't execute their own strategies without appropriate, executable, measurable goals.

So where do you start?

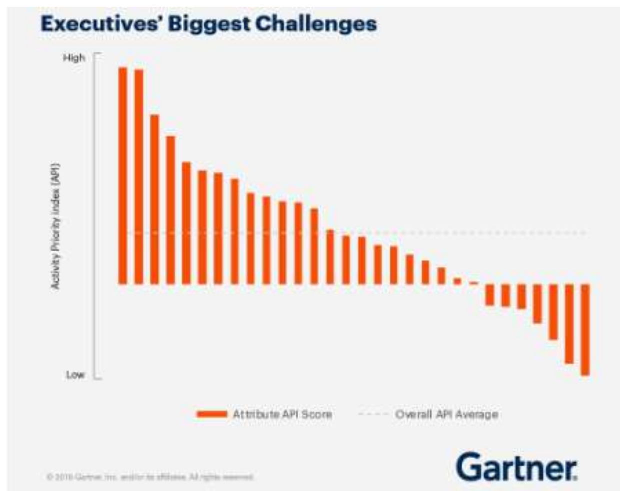
Step 1: Set ground rules.

Step 2: Verify the business imperative.

Step 3: Assess your functional capabilities.

Step 4: Define your objectives.

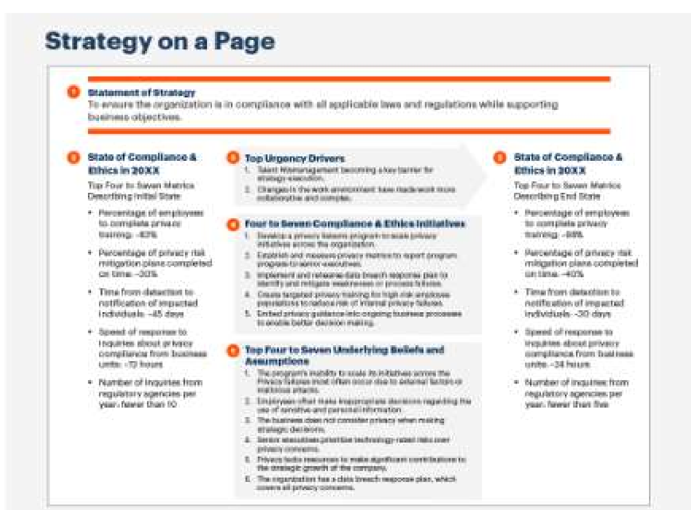
Step 5: Establish an action plan with measures and metrics.



Put your strategy on a page

Once you have tackled each element of the strategic planning process, you're ready to summarize the strategy on a single page.

Clarify where the functional organization is, where it is going and how it will get there. Communicate how you are adding value today and demonstrate how you plan to impact future business throughout the coming year.



Effectively communicate and execute your strategic plan

The next step is to communicate the functional objectives and strategy across the function and the company. Provide managers with a checklist to help them effectively convey key messages about functional strategy to employees.

Once the strategic plan is complete and communicated, it’s critical to measure progress against the objectives, revisit and monitor the plan to ensure it remains valid, and adapt the strategy as business conditions change.

<u>Identifying Key Organizational Objective And Process</u>

Planning Process:

Planning is the first primary function of management that precedes all other functions. The planning function involves the decision of what to do and how it is to be done? So managers focus a lot of their attention on planning and the planning process. Let us take a look at the eight important steps of the planning process**.**

1] Recognizing Need for Action

An important part of the planning process is to be aware of the business opportunities in the firm’s external environment as well as within the firm. Once such opportunities get recognized the managers can recognize the actions that need to be taken to realize them. A realistic look must be taken at the prospect of these new opportunities and a SWOT analysis should be done.

Say for example the government plans on promoting cottage industries in semi-urban areas. A firm can look to explore this opportunity.

2] Setting Objectives

This is the second and perhaps the most important step of the planning process. Here we establish the objectives for the whole organization and also individual departments. Organizational objectives provide a general direction, objectives of departments will be more planned and detailed.

Objectives can be long term and short term as well. They indicate the end result the company wishes to achieve. So objectives will percolate down from the managers and will also guide and push the employees in the correct direction.

3] Developing Premises

Planning is always done keeping the future in mind, however, the future is always uncertain. So in the function of management certain assumptions will have to be made. These assumptions are the premises. Such assumptions are made in form of forecasts, existing plans, past policies etc.

These planning premises are also of two types – internal and external. External assumptions deal with factors such as political environment, social environment, advancement of technology, competition, government policies etc. Internal assumptions deal with policies, availability of resources, quality of management etc.

These assumptions being made should be uniform across the organization. All managers should be aware of these premises and should agree with them.

4] Identifying Alternatives

The fourth step of the planning process is to identify the alternatives available to the managers. There is no one way to achieve the objectives of the firm, there is a multitude of choices. All of these alternative courses should be identified. There must be options available to the manager.

Maybe he chooses an innovative alternative hoping for more efficient results. If he does not want to experiment he will stick to the more routine course of action. The problem with this step is not finding the alternatives but narrowing them down to a reasonable amount of choices so all of them can be thoroughly evaluated.

5] Examining Alternate Course of Action

The next step of the planning process is to evaluate and closely examine each of the alternative plans. Every option will go through an examination where all there pros and cons will be weighed. The alternative plans need to be evaluated in the light of the organizational objectives.

For example, if it is a financial plan. Then it that case its risk-return evaluation will be done. Detailed calculation and analysis are done to ensure that the plan is capable of achieving the objectives in the best and most efficient manner possible.

6] Selecting the Alternative

Finally, we reach the decision making stage of the planning process. Now the best and most feasible plan will be chosen to be implemented. The ideal plan is the most profitable one with the least amount of negative consequences and is also adaptable to dynamic situations.

The choice is obviously based on scientific analysis and mathematical equations. But a managers intuition and experience should also play a big part in this decision. Sometimes a few different aspects of different plans are combined to come up with the one ideal plan.

7] Formulating Supporting Plan

Once you have chosen the plan to be implemented, managers will have to come up with one or more supporting plans. These secondary plans help with the implementation of the main plan. For example plans to hire more people, train personnel, expand the office etc are supporting plans for the main plan of launching a new product. So all these secondary plans are in fact part of the main plan.

8] Implementation of the Plan

And finally, we come to the last step of the planning process, implementation of the plan. This is when all the other functions of management come into play and the plan is put into action to achieve the objectives of the organization. The tools required for such implementation involve the types of plans- procedures, policies, budgets, rules, standards etc.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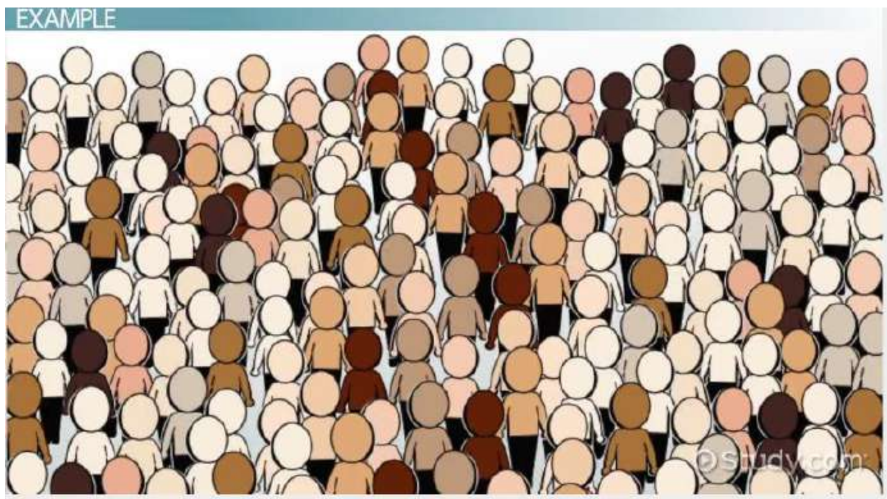


The Organizational Process

Organizing, like planning, must be a carefully worked out and applied process. This process involves determining what work is needed to accomplish the goal, assigning those tasks to individuals, and arranging those individuals in a decision-making framework (organizational structure). The end result of the organizing process is an **organization** — a whole consisting of unified parts acting in harmony to execute tasks to achieve goals, both effectively and efficiently. A properly implemented organizing process should result in a work environment where all team members are aware of their responsibilities. If the organizing process is not conducted well, the results may yield confusion, frustration, loss of efficiency, and limited effectiveness.In general, the organizational process consists of five steps (a flowchart of these steps is shown in Figure 1):

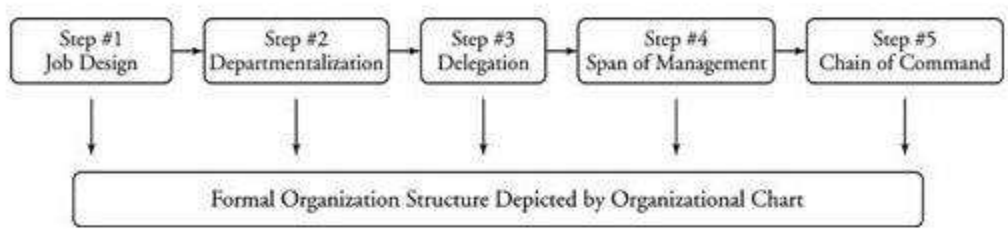


Figure 1 The organizational process.

1.Review plans and objectives.

Objectives are the specific activities that must be completed to achieve goals. Plans shape the activities needed to reach those goals. Managers must examine plans initially and continue to do so as plans change and new goals are developed.

2.Determine the work activities necessary to accomplish objectives.

Although this task may seem overwhelming to some managers, it doesn't need to be. Managers simply list and analyze all the tasks that need to be accomplished in order to reach organizational goals.

3.Classify and group the necessary work activities into manageable units.

A manager can group activities based on four models of departmentalization: functional, geographical, product, and customer.

4. Assign activities and delegate authority.

Managers assign the defined work activities to specific individuals. Also, they give each individual the authority (right) to carry out the assigned tasks.

5.Design a hierarchy of relationships.

A manager should determine the vertical (decision-making) and horizontal (coordinating) relationships of the organization as a whole. Next, using the organizational chart, a manager should diagram the relationships.

Types of Plan:

Planning is a pervasive function of management, it is extensive in its scope. So all managers across all levels participate in planning. However, the plans made by the top level manager will differ from the ones that lower managers make.Plans also differ from what they seek to achieve and what methods will be used to achieve them. So let us look at the types of plans that managers deal with.

Objectives

This is the first step in planning the action plan of the organization. Objectives are the basics of every company and the desired objective/result that the company plans on achieving, so they are the endpoint of every planning activity.

For example one of the objectives of an organization could be to increase sales by 20%. So the manager will plan all activities of the organization with this end objective in mind. While framing the objectives of the organization some points should be kept in mind.

- Objectives should be framed for a single activity in mind.
- They should be result oriented. The objective must not frame any actions
- Objectives should not be vague, they should be quantitative and measurable.
- They should not be unrealistic. Objectives must be achievable.

Strategy

This obviously is the next type of plan, the next step that follows objectives. A strategy is a complete and all-inclusive plan for achieving said objectives. A strategy is a plan that has three specific dimensions

i. Establishing long-term objectives
ii. Selecting a specific course of action
iii. allocating the necessary resources needed for the plan

Forming strategy is generally reserved for the top level of management. It actually defines all future decisions and the company's long-term scope and general direction.

Policy

Policies are generic statements, which are basically a guide to channelize energies towards a particular strategy. It is an organization's general way of understanding, interpreting and implementing strategies. Like for example, most companies have a return policy or recruitment policy or pricing policy etc.

Policies are made across all levels of management, from major policies at the top-most level to minor policies. The managers need to form policies to help the employees navigate a situation with predetermined decisions. They also help employees to make decisions in unexpected situations.

Procedure

Procedures are the next types of plan. They are a stepwise guide for the routine to carry out the activities. These stepwise sequences are to be followed by all the employees so the activities can be fulfilled in an organized manner.

The procedures are described in a chronological order. So when the employees follow the instructions in the order and completely, the success of the activity is pretty much guaranteed.

Take for example the procedure of admission of a student in a college. The procedure starts with filling out an application form. It will be followed by a collection of documents and sorting the applications accordingly.

Rules

Rules are very specific statements that define an action or non-action. Also, rules allow for no flexibility at all, they are final. All employees of the organization must compulsorily follow and implement the rules. Not following rules can have severe consequences.

Rules create an environment of discipline in the organization. They guide the actions and the behaviour of all the employees of the organization. The rule of “no smoking” is one such example.

Program

Programmes are an in-depth statement that outlines a company’s policies, rules, objectives, procedures etc. These programmes are important in the implementation of all types of plan. They create a link between the company’s objectives, procedures and rules.

Primary programmes are made at the top level of management. To support the primary program all managers will make other programs at the middle and lower levels of management.

Methods

Methods prescribe the ways in which in which specific tasks of a procedure must be performed. Also, methods are very specific and detailed instructions on how the employees must perform every task of the planned procedure. So managers form methods to formalize routine jobs.

Methods are very important types of plan for an organization. They help in the following ways

- give clear instructions to the employees, removes any confusion
- Ensures uniformity in the actions of the employees
- Standardizes the routine jobs
- Acts as an overall guide for the employees and the managers

Budget

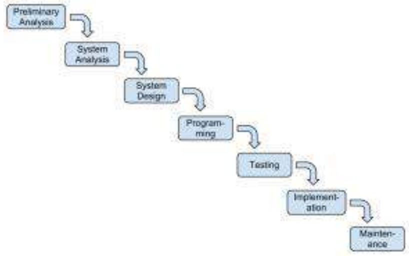
A budget is a statement of expected results the managers expect from the company. Budgets are also a quantitative statement, so they are expressed in numerical terms. A budget quantifies the forecast or future of the organization.

There are many types of budgets that managers make. There is the obvious financial budget, that forecasts the profit of the company. Then there are operational budgets generally prepared by lower-level managers. Cash budgets monitor the cash inflows and outflows of the company.

Developing an Information System Development Process:

Systems-Development Life Cycle

The first development methodology we are going to review is the systems-development life cycle (SDLC). This methodology was first developed in the 1960s to manage the large software projects associated with corporate systems running on mainframes. It is a very structured and risk-averse methodology designed to manage large projects that included multiple programmers and systems that would have a large impact on the organization.



SDLC waterfall

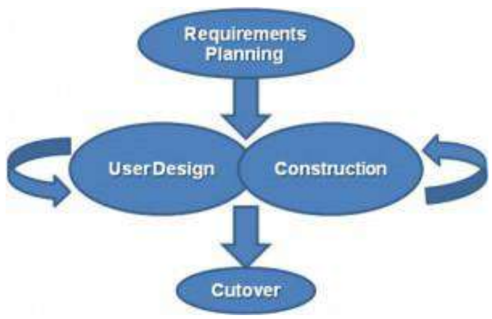
Various definitions of the SDLC methodology exist, but most contain the following phases.

1. Preliminary Analysis. In this phase, a review is done of the request. Is creating a solution possible? What alternatives exist? What is currently being done about it? Is this project a good fit for our organization? A key part of this step is a feasibility analysis, which includes an analysis of the technical feasibility (is it possible to create this?), the economic feasibility (can we afford to do this?), and the legal feasibility (are we allowed to do this?). This step is important in determining if the project should even get started.
2. System Analysis. In this phase, one or more system analysts work with different stakeholder groups to determine the specific requirements for the new system. No programming is done in this step. Instead, procedures are documented, key players are interviewed, and data requirements are developed in order to get an overall picture of exactly what the system is supposed to do. The result of this phase is a system-requirements document.
3. System Design. In this phase, a designer takes the system-requirements document created in the previous phase and develops the specific technical details required for the system. It is in this phase that the business requirements are translated into specific technical requirements. The design for the user interface, database, data inputs and outputs, and reporting are developed here. The result of this phase is a system-design document. This document will have everything a programmer will need to actually create the system.
4. Programming. The code finally gets written in the programming phase. Using the system-design document as a guide, a programmer (or team of programmers) develop the program. The result of this phase is an initial working program that meets the requirements laid out in the system-analysis phase and the design developed in the system-design phase.
5. Testing. In the testing phase, the software program developed in the previous phase is put through a series of structured tests. The first is a unit test, which tests individual parts of the code for errors or bugs. Next is a system test, where the different components of the system are tested to ensure that they work together properly. Finally, the user-acceptance test allows those that will be using the software to test the system to ensure that it meets their standards. Any bugs, errors, or problems found during testing are addressed and then tested again.
6. Implementation. Once the new system is developed and tested, it has to be implemented in the organization. This phase includes training the users, providing documentation, and conversion from any previous system to the new system. Implementation can take many forms, depending on the type of system, the number and type of users, and how urgent it is that the system become operational. These different forms of implementation are covered later in the chapter.
7. Maintenance. This final phase takes place once the implementation phase is complete. In this phase, the system has a structured support process in place: reported bugs are fixed and requests for new features are evaluated and implemented; system updates and backups are performed on a regular basis.

The SDLC methodology is sometimes referred to as the waterfall methodology to represent how each step is a separate part of the process; only when one step is completed can another step begin. After each step, an organization must decide whether to move to the next step or not. This methodology has been criticized for being quite rigid. For example, changes to the requirementsare not allowed once the process has begun. No software is available until after the programming phase.

Again, SDLC was developed for large, structured projects. Projects using SDLC can sometimes take months or years to complete. Because of its inflexibility and the availability of new programming techniques and tools, many other software-development methodologies have been developed. Many of these retain some of the underlying concepts of SDLC but are not as rigid.

Rapid Application Development



The RAD methodology

Rapid application development (RAD) is a software-development (or systems-development) methodology that focuses on quickly building a working model of the software, getting feedback from users, and then using that feedback to update the working model. After several iterations of development, a final version is developed and implemented.

The RAD methodology consists of four phases:

1. Requirements Planning. This phase is similar to the preliminary-analysis, system-analysis, and design phases of the SDLC. In this phase, the overall requirements for the system are defined, a team is identified, and feasibility is determined.
2. User Design. In this phase, representatives of the users work with the system analysts, designers, and programmers to interactively create the design of the system. One technique for working with all of these various stakeholders is the so-called JAD session. JAD is an acronym for joint application development. A JAD session gets all of the stakeholders together to have a structured discussion about the design of the system. Application developers also sit in on this meeting and observe, trying to understand the essence of the requirements.
3. Construction. In the construction phase, the application developers, working with the users, build the next version of the system.This is an interactive process, and changes can be made as developers are working on the program. This step is executed in parallel with the User Design step in an iterative fashion, until an acceptable version of the product is developed.

4. Cutover. In this step, which is similar to the implementation step of the SDLC, the system goes live. All steps required to move from the previous state to the use of the new system are completed here.

As you can see, the RAD methodology is much more compressed than SDLC. Many of the SDLC steps are combined and the focus is on user participation and iteration. This methodology is much better suited for smaller projects than SDLC and has the added advantage of giving users the ability to provide feedback throughout the process. SDLC requires more documentation and attention to detail and is well suited to large, resource-intensive projects. RAD makes more sense for smaller projects that are less resource-intensive and need to be developed quickly.

Agile Methodologies

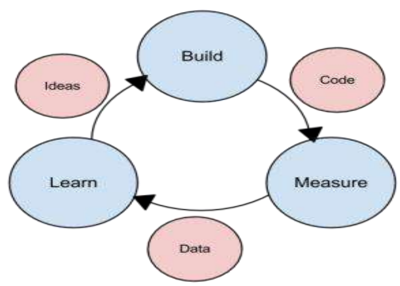
Agile methodologies are a group of methodologies that utilize incremental changes with a focus on quality and attention to detail. Each increment is released in a specified period of time (called a time box), creating a regular release schedule with very specific objectives. While considered a separate methodology from RAD, they share some of the same principles: iterative development, user interaction, ability to change. The agile methodologies are based on the "Agile Manifesto," first released in 2001.

The characteristics of agile methods include:

- small cross-functional teams that include development-team members and users;
- daily status meetings to discuss the current state of the project;
- short time-frame increments (from days to one or two weeks) for each change to be completed; and
- at the end of each iteration, a working project is completed to demonstrate to the stakeholders.

The goal of the agile methodologies is to provide the flexibility of an iterative approach while ensuring a quality product.

Lean Methodology



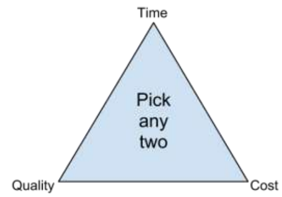
The lean methodology

In this methodology, the focus is on taking an initial idea and developing a minimum viable product (MVP). The MVP is a working software application with just enough functionality to demonstrate the idea behind the project. Once the MVP is developed, it is given to potential users for review. Feedback on the MVP is generated in two forms:

(1) direct observation and discussion with the users
(2) usage statistics gathered from the software itself.
(3) Using these two forms of feedback, the team determines whether they should continue in the same direction or rethink the core idea behind the project, change the functions, and create a new MVP. This change in strategy is called a pivot. Several iterations of the MVP are developed, with new functions added each time based on the feedback, until a final product is completed.

The biggest difference between the lean methodology and the other methodologies is that the full set of requirements for the system are not known when the project is launched. As each iteration of the project is released, the statistics and feedback gathered are used to determine the requirements. The lean methodology works best in an entrepreneurial environment where a company is interested in determining if their idea for a software application is worth developing.

The Quality Triangle



The quality triangle

When developing software, or any sort of product or service, there exists a tension between the developers and the different stakeholder groups, such as management, users, and investors. This tension relates to how quickly the software can be developed (time), how much money will be spent (cost), and how well it will be built (quality). The quality triangle is a simple concept. It states that for any product or service being developed, you can only address two of the following: time, cost, and quality.

So what does it mean that you can only address two of the three? It means that you cannot complete a low-cost, high-quality project in a small amount of time. However, if you are willing or able to spend a lot of money, then a project can be completed quickly with high-quality results (through hiring more good programmers). If a project's completion date is not a priority, then it can be completed at a lower cost with higher-quality results. Of course, these are just generalizations, and different projects may not fit this model perfectly. But overall, this model helps us understand the tradeoffs that we must make when we are developing new products and services.

User Role In System Development Process:

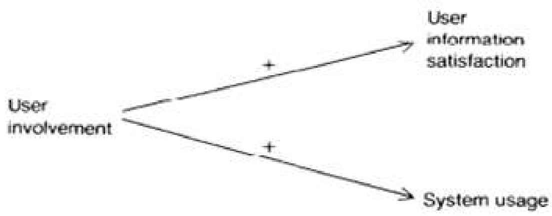
User involvement in the field of information system development is usually considered as vital mechanism to enhance system quality and ensure successful system implementation. The importance of user orientation in innovation activities is emphasized in business filed as well as in political and societal discussions.

The Traditional Model: There are various models of user involvement and its impact on user information satisfaction and system usage which have been explicitly tested in previous research. The traditional model theorizes that user involvement leads to increases in both user information satisfaction and system usage. Apparently, involvement will lead users to develop good understanding of the system, and it will be better tailored to their specific needs. Therefore, they will be more motivated to use the system and be more gratified with it than if they had not been involved in its design. Several studies have explored the relation between user involvement and system usage. It has been found that there are mixed results regarding the relationship between user involvement and user information satisfaction. Several studies reported a significant positive relationship.

It is assumed that the user involvement will enhance system usage and user information satisfaction is consistent with the theories of participative decision making and planned organizational change. Ives and Olson debated that user involvement can be regarded as a special case of participative decision making; involvement may lead to improved system quality as well as increased user acceptance, reflected in increased use of satisfaction with the system. Involvement is seen as a necessary condition for decreasing resistance and increasing acceptance of planned change.

It can be supposed that the empirical evidence is diverse regarding the relationships between user involvement, system usage, and user information satisfaction. Nonetheless, the empirical support which has been found for these relationships is reliable with theories of participative decision making and organizational change.

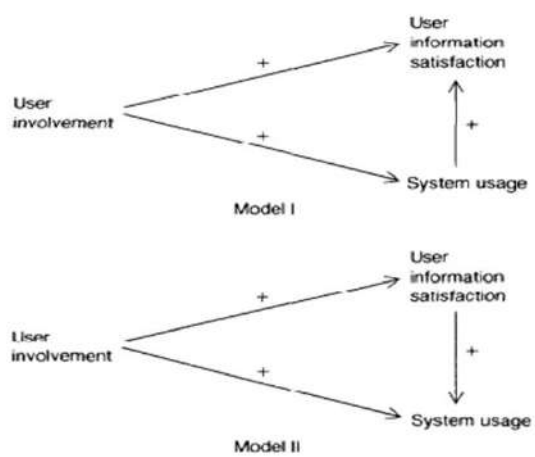
Traditional model



System Usage and Information Satisfaction

- Though the theoretical literature is clear with regard to the causal relationship between user involvement, system usage, and user information satisfaction, it is silent regarding the causal relationship between system usage and user information satisfaction. Building on the traditional model of user involvement and its outcomes, two competing models of the relationship between system usage and user information satisfaction development. In both models, use of the system is expected to be voluntary.
- Model I conjectures that user involvement will lead to both system usage and user information fulfilment but as system usage increases it leads to improved user information satisfaction. This model is based on the conviction that system use leads users to be more acquainted with the system and to ascertain new uses for it which will, in turn, lead to enhanced user satisfaction with the system.
- Model II suggests that user involvement will also lead to both system usage and user information satisfaction but that the more satisfied the user is with the system the more he or she will be inclined to use it. This model assumes that as use demonstrates that a system meets a user's needs, satisfaction with the system should increase, which should further lead to greater use of that system. Contrariwise, if system use does not fulfil the user's needs, satisfaction will not increase and further use will be evaded.

Alternatemodels:



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Significance of User Involvement

User involvement is an important aspect in the system development. Many methodologies concern with users in the development phases. It embodies the view of users, not systems analysts, programmers, or the data services organization . It has several important aspects in information system development.

In the system development, especially in the initial (feasibility) study and design phases, system developers need to observe the existing problems and identify the requirements for the new system. Because usually except system developers who have worked in the current system for a long period, most developers are not familiar with the current system, they cannot have thorough understanding of the system environment.

Subsequently if they want to understand the current system, best way is to communicate with the end-users of the current system. Beyer and Holtzblatt (1995) claim that users are experts in their work and a thorough understanding of the requirements is reached only by promoting effective communication with them during the requirements definition process. It is obliging to establish a channel between the users and system developers for exchanging the information. However, because of limited fund and time requirements, it is incredible to involve all users in the process. So, system developers have to select users carefully aiming to get most valuable information.

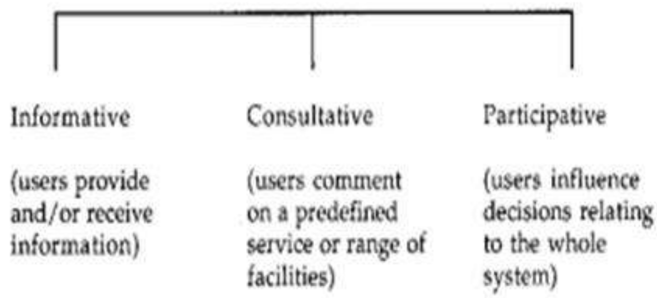
Another importance of user involvement is that it can help the system developers to get fast and easy methodologies .It means system developers can assess and verify data from the secondary sources to recognise users' requirements, thus, system developers can apply more appropriate methodology. Additionally, user involvement can lead to the simpler methods to design and validate the system software functionality.

User involvement can offer the more reliable ways to organize features into menus and dialog boxes based on user data . In the earlier system development methodologies, system developers seldom to consider the users' working habits, when the new system is applied in the environment, end-users always have problem to manipulate although system developers believe the system is reliable and easy to use.

User involvement can reduce or even eliminate the clash between users and system developers in the system function views. By cooperating with users, system developers find data and information direct from the users; understand needs of the users and help users to have an initial understanding of the new system. After further negotiation with the users, system developers and users can get consensus on the new system.

However users can be considered as the experts of the current system environment, so developers can know ordinary language used in the environment from users. If system developers can use the same "language" to communicate with the users, system development efficiency can be sped up.

Major issues of user involvement: There are many issues associated with user involvement: Context of user involvement: Since last decades, it has been observed that many information technology (IT) systems have unsuccessful to deliver the benefits expected by the users. Insufficient involvement of users in the design process is cited as a major factor contributing to this underperformance between expectation and reality. All approaches to system design involve users in the design process. The difference between the various approaches lies in the degree to which users are able to influence the system design. In these methodologies users make a considerable contribution to the project but often do not influence key decisions. The danger remains that the eventual IT development will fail to reflect passably real human and organizational needs. Dissatisfaction and two decades of experience of IT failing to deliver the expected rewards have led to increasing attempts to involve users in a more influence role.



Benefits and pitfalls of user involvement

It has been found in numerous studies that effective involvement in system design produces the following benefits :

1. Improved quality of the system arising from more accurate user requirements.
2. Avoiding costly system features that the user did not want or cannot use.
3. Improved levels of acceptance of the system.
4. Greater understanding of the system by the user resulting in more effective use.
5. Increased participation in decision-making in the organization.

Maintainability And Recoverability In System Design

- ❖ Evaluation of operational engineering availability and maintainability is usually considered in the detail design phase, or after installation of an engineering design. It deals with the prediction and assessment of the design’s availability, or the probability that a system will be in operational service during a scheduled operating period, as well as the design’s maintainability, or the probability of system restoration within a specified downtime.
- ❖ The concepts of availability and maintainability in engineering design, as well as the various criteria essential to designing for availability and designing for maintainability. Availability in engineering design has its roots in designing for reliability.
- ❖ If the design includes a durability feature related to its availability and reliability, then it fulfils, to a large extent, the requirements for engineering design integrity. Availability in engineering design is thus considered from the perspective of the design’s functional and operational characteristics, and designing for availability, particularly engineering process availability, considers measurements of process throughput, output, input and capacity.
- ❖ Designing for availability is a ‘top-down’ approach from the design’s systems level to its equipment or assemblies level whereby constraints on the design’s functional and operational performance are determined. Maintainability in engineering design is the relative ease and economy of time and resources with which an engineered installation can be retained in, or restored to, a specified condition through scheduled and unscheduled maintenance.

In this context, maintainability is a function of engineering design. Therefore, designing for maintainability requires that the installation is serviceable and can be easily repaired, and also supportable in that it can be cost-effectively and practically kept in or restored to a usable condition. Maintainability is fundamentally a design parameter, and designing for maintainability defines the time an installation could be inoperable.

UNIT - II:
Representation And Analysis Of System Structure
Models for Representing Systems: Mathematical, Graphical and Hierarchical organization Chart, Tree Diagram) – Information Flow – Process Flow – Methods and Heuristics – Decomposition and Aggregation – Information Architecture – Application of System Representation to Case Studies.

Mathematical Model:

A mathematical model is a description of a system using mathematical concepts and language. The process of developing a mathematical model is termed mathematical modeling. Mathematical models are used in the natural sciences (such as physics, biology, earth science, chemistry) and engineering disciplines (such as computer science, electrical engineering), as well as in the social sciences (such as economics, psychology, sociology, political science).
A model may help to explain a system and to study the effects of different components, and to make predictions about behaviour.
Elements of a mathematical model
Mathematical models can take many forms, including dynamical systems, statistical models, differential equations, or game theoretic models. These and other types of models can overlap, with a given model involving a variety of abstract structures. In general, mathematical models may include logical models. In many cases, the quality of a scientific field depends on how well the mathematical models developed on the theoretical side agree with results of repeatable experiments. Lack of agreement between theoretical mathematical models and experimental measurements often leads to important advances as better theories are developed.
In the physical sciences, a traditional mathematical model contains most of the following elements:

1. Governing equations
2. Supplementary sub-models
    1. Defining equations
    2. Constitutive equations
3. Assumptions and constraints
    1. Initial and boundary conditions
    2. Classical constraints and kinematic equations

Classifications[edit]

Mathematical models are usually composed of relationships and *variables*. Relationships can be described by *operators*, such as algebraic operators, functions, differential operators, etc. Variables are abstractions of system parameters of interest, that can be quantified. Several classification criteria can be used for mathematical models according to their structure:

- **Linear vs. nonlinear:** If all the operators in a mathematical model exhibit linearity, the resulting mathematical model is defined as linear. A model is considered to be nonlinear otherwise. The definition of linearity and nonlinearity is dependent on context, and linear models may have nonlinear expressions in them. For example, in a statistical linear model, it is assumed that a relationship is linear in the parameters, but it may be nonlinear in the predictor variables. Similarly, a differential equation is said to be linear if it can be written with linear differential operators, but it can still have nonlinear expressions in it. In a mathematical programming model, if the objective functions and constraints are represented entirely by linear equations, then the model is regarded as a linear model. If one or more of the objective functions or constraints are represented with a nonlinear equation, then the model is known as a nonlinear model.
  Nonlinearity, even in fairly simple systems, is often associated with phenomena such

as chaos and irreversibility. Although there are exceptions, nonlinear systems and models tend to be more difficult to study than linear ones. A common approach to nonlinear problems is linearization, but this can be problematic if one is trying to study aspects such as irreversibility, which are strongly tied to nonlinearity.

- **Static vs. dynamic:** A *dynamic* model accounts for time-dependent changes in the state of the system, while a *static* (or steady-state) model calculates the system in equilibrium, and thus is time-invariant. Dynamic models typically are represented by differential equations or difference equations.
- **Explicit vs. implicit:** If all of the input parameters of the overall model are known, and the output parameters can be calculated by a finite series of computations, the model is said to be *explicit*. But sometimes it is the *output* parameters which are known, and the corresponding inputs must be solved for by an iterative procedure, such as Newton's method (if the model is linear) or Broyden's method (if non-linear). In such a case the model is said to be *implicit*. For example, a jet engine's physical properties such as turbine and nozzle throat areas can be explicitly calculated given a design thermodynamic cycle (air and fuel flow rates, pressures, and temperatures) at a specific flight condition and power setting, but the engine's operating cycles at other flight conditions and power settings cannot be explicitly calculated from the constant physical properties.
- **Discrete vs. continuous:** A discrete model treats objects as discrete, such as the particles in a molecular model or the states in a statistical model; while a continuous model represents the objects in a continuous manner, such as the velocity field of fluid in pipe flows, temperatures and stresses in a solid, and electric field that applies continuously over the entire model due to a point charge.
- **Deterministic vs. probabilistic (stochastic):** A deterministic model is one in which every set of variable states is uniquely determined by parameters in the model and by sets of previous states of these variables; therefore, a deterministic model always performs the same way for a given set of initial conditions. Conversely, in a stochastic model—usually called a "statistical model"—randomness is present, and variable states are not described by unique values, but rather by probability distributions.
- **Deductive, inductive, or floating:** A deductive model is a logical structure based on a theory. An inductive model arises from empirical findings and generalization from them. The floating model rests on neither theory nor observation, but is merely the invocation of expected structure. Application of mathematics in social sciences outside of economics has been criticized for unfounded models.[1] Application of catastrophe theory in science has been characterized as a floating model.

Building blocks

In business and engineering, mathematical models may be used to maximize a certain output. The system under consideration will require certain inputs. The system relating inputs to outputs depends on other variables too: decision variables, state variables, exogenous variables, and random variables.
Decision variables are sometimes known as independent variables. Exogenous variables are sometimes known as parameters or constants. The variables are not independent of each other as the state variables are dependent on the decision, input, random, and exogenous variables. Furthermore, the output variables are dependent on the state of the system (represented by the state variables).
Objectives and constraints of the system and its users can be represented as functions of the output variables or state variables.

A priori information

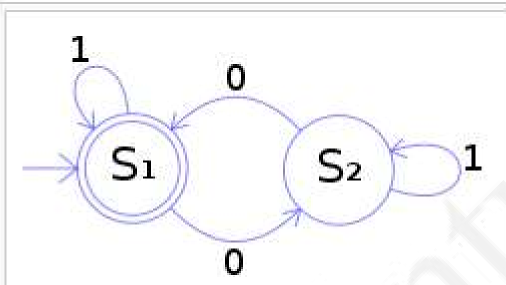
Mathematical modeling problems are often classified into black box or white box models, according to how much a priori information on the system is available. A black-box model is a system of which there is no a priori information available. A white-box model (also called glass box or clear box) is a system where all

necessary information is available. Practically all systems are somewhere between the black-box and white-box models, so this concept is useful only as an intuitive guide for deciding which approach to take.
Examples
One of the popular examples in computer science is the mathematical models of various machines, an example is the deterministic finite automaton (DFA) which is defined as an abstract mathematical concept, but due to the deterministic nature of a DFA, it is implementable in hardware and software for solving various specific problems. For example, the following is a DFA M with a binary alphabet, which requires that the input contains an even number of 0s.

$M = (Q, \Sigma, \delta, q_0, F)$ where

- $Q = \{S_1, S_2\}$,
- $\Sigma = \{0, 1\}$,
- $q_0 = S_1$,
- $F = \{S_1\}$, and
- δ is defined by the following state transition table:

	0	**1**
$\mathbf{S_1}$	S_2	S_1
$\mathbf{S_2}$	S_1	S_2

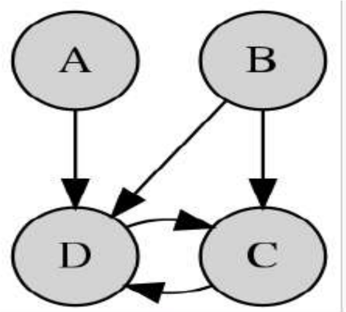


The state diagram for M

The state S_1 represents that there has been an even number of 0s in the input so far, while S_2 signifies an odd number. A 1 in the input does not change the state of the automaton. When the input ends, the state will show whether the input contained an even number of 0s or not. If the input did contain an even number of 0s, M will finish in state S_1, an accepting state, so the input string will be accepted.
The language recognized by M is the regular language given by the regular expression 1*(0 (1*) 0 (1*))*, where "*" is the Kleene star, e.g., 1* denotes any non-negative number (possibly zero) of symbols "1".

GRAPHICAL MODEL:

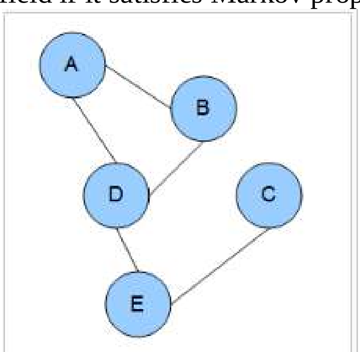
A **graphical model** or **probabilistic graphical model** (**PGM**) or **structured probabilistic model** is a probabilistic model for which a graph expresses the conditional dependence structure between random variables. They are commonly used in probability theory, statistics—particularly Bayesian statistics—and machine learning.



An example of a graphical model. Each arrow indicates a dependency. In this example: D depends on A, B, and C; and C depends on B and D; whereas A and B are each independent.

The two most common forms of graphical model are directed graphical models and undirected graphical models, based on directed acylic graphs and undirected graphs, respectively.

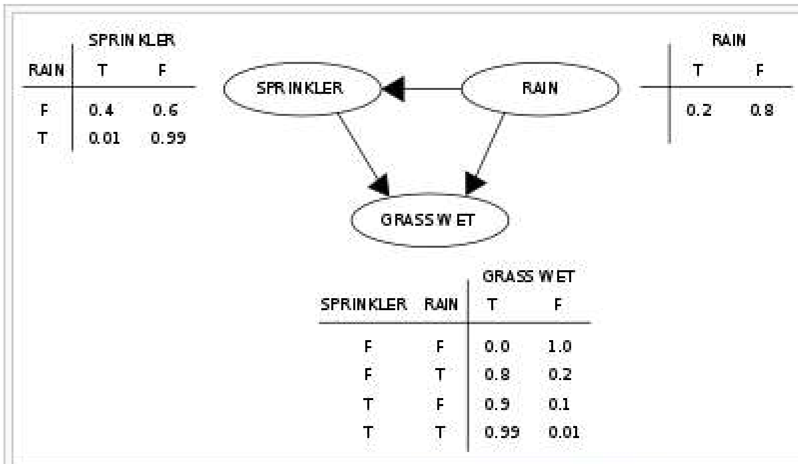
Markov network or **undirected graphical model** is a set of random variables having a Markov property described by an undirected graph. In other words, a random field is said to be a Markov random field if it satisfies Markov properties.



An example of a Markov random field. Each edge represents dependency. In this example: A depends on B and D. B depends on A and D. D depends on A, B, and E. E depends on D and C. C depends on E.

Bayesian networks are directed acyclic graphs(DAGs) whose nodes represent variables in the Bayesian sense: they may be observable quantities, latent variables, unknown parameters or hypotheses. Edges represent conditional dependencies; nodes that are not connected (no path connects one node to another) represent variables that are conditionally independent of each other. Each node is associated with a probability function that takes, as input, a particular set of values for the node's parent variables, and gives (as output) the probability (or probability distribution, if applicable) of the variable represented by the node.

Example
Two events can cause grass to be wet: an active sprinkler or rain. Rain has a direct effect on the use of the sprinkler (namely that when it rains, the sprinkler usually is not active). This situation can be modeled with a Bayesian network (shown to the right). Each variable has two possible values, T (for true) and F (for false).



A simple Bayesian network with conditional probability tables

The joint probability function is:

$$\Pr(G,S,R) = \Pr(G \mid S,R)\Pr(S \mid R)\Pr(R)$$

where G = "Grass wet (true/false)", S = "Sprinkler turned on (true/false)", and R = "Raining (true/false)".

The model can answer questions about the presence of a cause given the presence of an effect (so-called inverse probability) like "What is the probability that it is raining, given the grass is wet?" by using the conditional probability formula and summing over all nuisance variables:

$$\Pr(R=T \mid G=T) = \frac{\Pr(G=T,R=T)}{\Pr(G=T)} = \frac{\sum_{S\in\{T,F\}}\Pr(G=T,S,R=T)}{\sum_{S,R\in\{T,F\}}\Pr(G=T,S,R)}$$

Using the expansion for the joint probability function $\Pr(G,S,R)$ and the conditional probabilities from the conditional probability tables (CPTs) stated in the diagram, one can evaluate each term in the sums in the numerator and denominator. For example,

$$\begin{aligned}\Pr(G=T,S=T,R=T) &= \Pr(G=T \mid S=T,R=T)\Pr(S=T \mid R=T)\Pr(R=T)\\ &= 0.99 \times 0.01 \times 0.2\\ &= 0.00198.\end{aligned}$$

Then the numerical results (subscripted by the associated variable values) are

$$\Pr(R=T \mid G=T) = \frac{0.00198_{TTT} + 0.1584_{TFT}}{0.00198_{TTT} + 0.288_{TTF} + 0.1584_{TFT} + 0.0_{TFF}} = \frac{891}{2491} \approx 35.77\%.$$

The simplest conditional independence relationship encoded in a Bayesian network can be stated as follows: a node is independent of its ancestors given its parents, where the ancestor/parent relationship is with respect to some fixed topological ordering of the nodes.

By the chain rule of probability, the joint probability of all the nodes in the graph above is

P(C, S, R, W) = P(C) * P(S|C) * P(R|C,S) * P(W|C,S,R)

By using conditional independence relationships, we can rewrite this as

P(C, S, R, W) = P(C) * P(S|C) * P(R|C) * P(W|S,R)

where we were allowed to simplify the third term because R is independent of S given its parent C, and the last term because W is independent of C given its parents S and R.

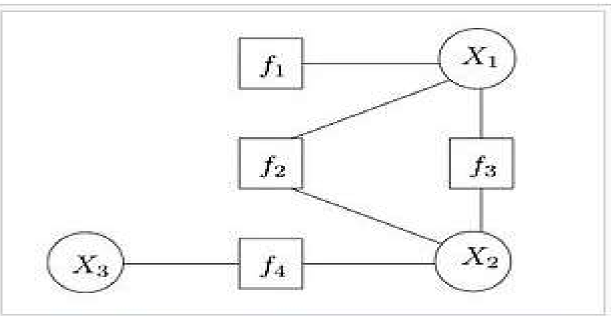
A **factor graph** is a bipartite graph representing the factorization of a function. In probability theory and its applications, factor graphs are used to represent factorization of a probability distribution function, enabling efficient computations, such as the computation of marginal distributions through the sum-product algorithm. One of the important success stories of factor graphs and the sum-product algorithm is the decoding of capacity-approaching error-correcting codes, such as LDPC and turbo codes.

Examples

Consider a function that factorizes as follows:

$$g(X_1, X_2, X_3) = f_1(X_1)f_2(X_1, X_2)f_3(X_1, X_2)f_4(X_2, X_3),$$

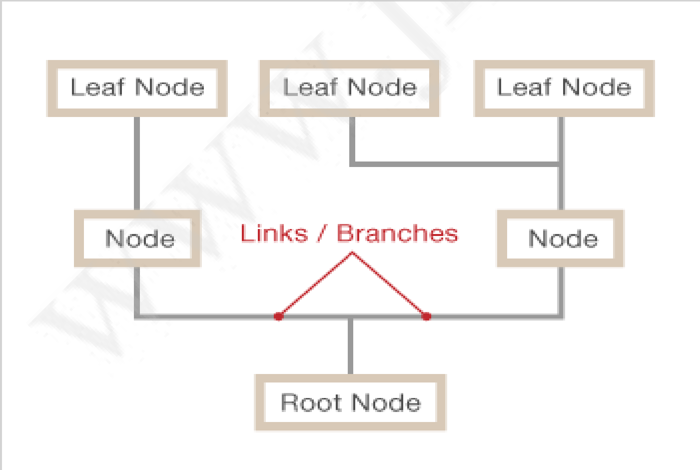
with a corresponding factor graph shown on the right. Observe that the factor graph has a cycle. If we merge $f_2(X_1, X_2)f_3(X_1, X_2)$ into a single factor, the resulting factor graph will be a tree. This is an important distinction, as message passing algorithms are usually exact for trees, but only approximate for graphs with cycles.



An example factor graph

Tree structure:

Tree structure Also known as a *Organisational chart*, *Linkage Tree*.A Tree Diagram is a way of visually representing hierarchy in a tree-like structure. Typically the structure of a Tree Diagram consists of elements such as a **root node**, a member that has no superior/parent. Then there are the **nodes**, which are linked together with line connections called **branches** that represent the relationships and connections between the members. Finally, the **leaf nodes** (or end-nodes) are members who have no children or child nodes.
Tree Diagrams are often used In businesses and organisations for managerial purposes.



Organizational charts are a good way to visualize reporting relationships and team roles in businesses, nonprofit organizations, educational institutions and governments.

The type of organization chart you need will reflect on the type of organization you have and what information you want to focus on conveying.

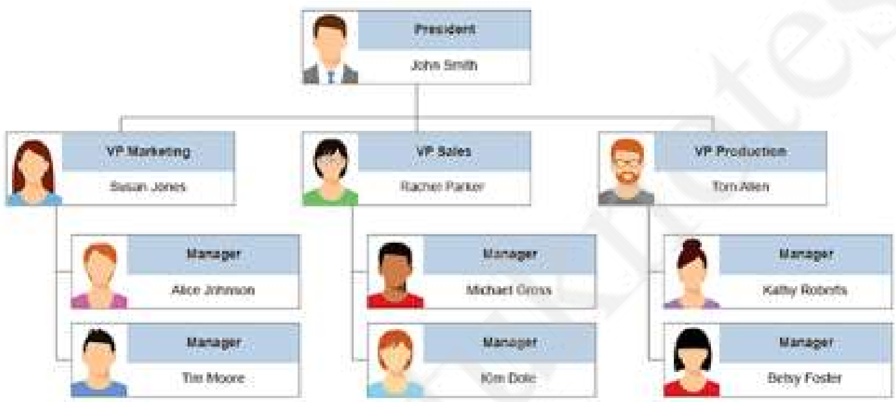
Here are four types of organizational charts:

1. Functional Top-Down
2. Divisional Structure
3. Matrix Organizational Chart
4. Flat Organizational Chart

Functional Top-Down Hierarchy

A functional, top-down organizational chart reflects a traditional business structure. This structure shows the C-Suite at the top, followed by other senior management, middle managers, and so on. The structure is divided into traditional departments like IT, marketing, finance, human resources, and operations based on everyone's functional role in the organization.

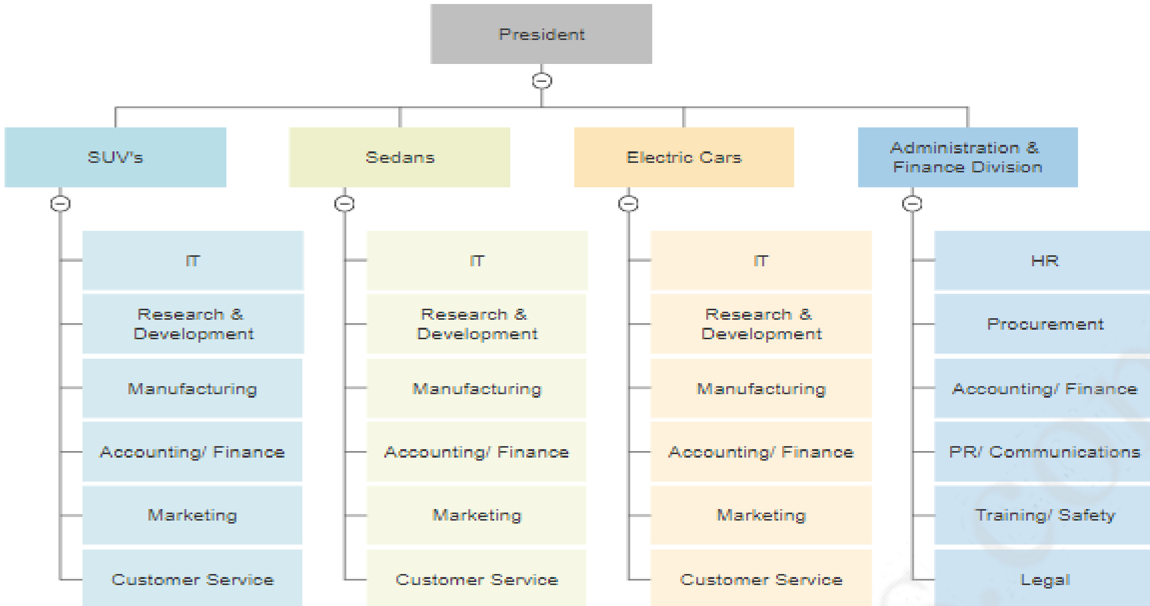
In such an organizational structure, employees with similar skillsets and specialization are grouped together. However, they often suffer from lack of visibility and communication with other departments.



Divisional Organizational Chart

A divisional organizational chart reflects a company organized along a product line or specific geogrophy. For example, in a car company the divisions may represent SUVs, sedans, and electric cars. Each division than has it own functional structure like IT and marketing.

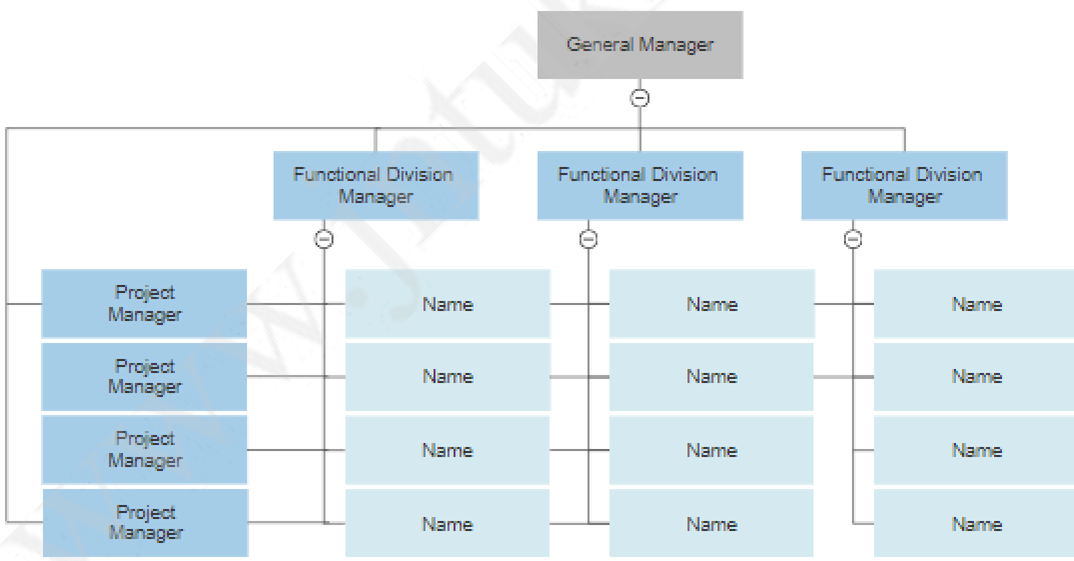
A company will use a divisional set up like this when one division is sufficiently independent from another, however this kind of structure can also add some accounting and other overhead.



Matrix Organizational Chart

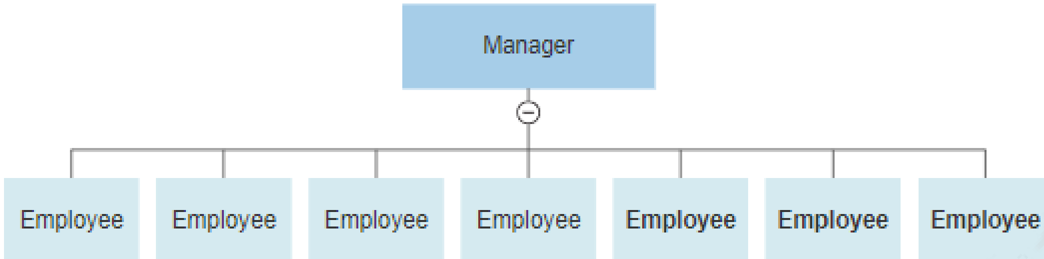
A matrix organizational chart reflects a company where employees are divided into teams by projects or product lead by a project or product manager, but also report to a functional manager. It shows a company that operates using cross-functional groups instead of vertical silos.

A matrix organizational structure can help facilite better, more open communication and create a flexible, dynamic work environment that can easily shift resources where they're needed, but it can also create confusion and frustration with dueling priorities and supervisors.



Flat Organizational Chart

A flat organization structure will show few or no levels of management between executives and all other employees. This type of structure empowers self-management and greater decision making ability for every employee. It's most often employed by smaller businesses, but it's not unheard of it even at larger companies.



Organizational Information Flow

Information flow in an organization in two ways:

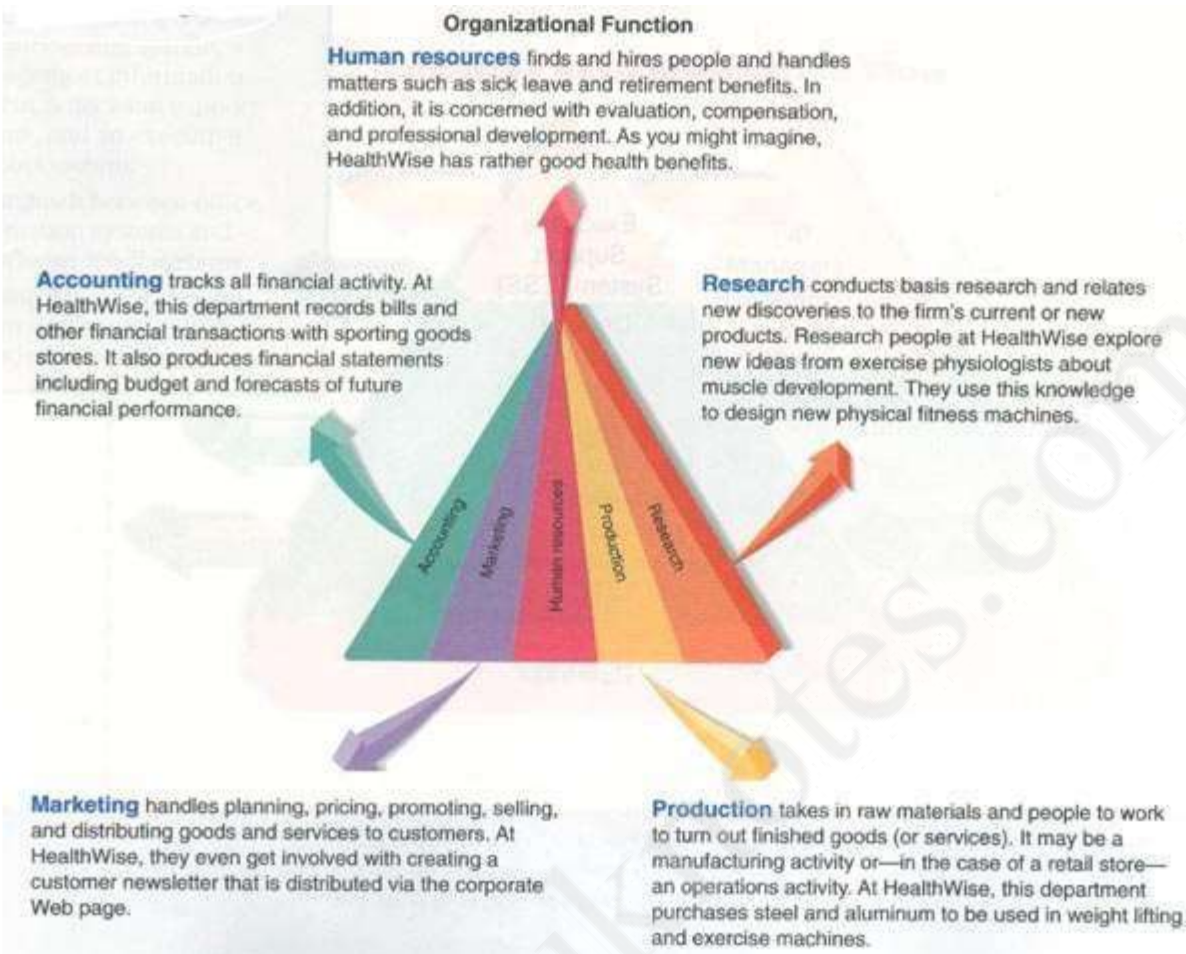
1. **Vertically -** Flow up and down among managers
   Example: Production supervisors constantly communicate with with production-line workers and their own managers.

2. **Horizontally** - Flow sideways among departments
   Example: Regional sales managers from the marketing department set their sales goals by coordinating with production managers in the production department.

Organizational Functions

Most organizations have departments that perform five basic functions:

1. **Accounting -** Keep track of all financial activities.
2. **Production -** Makes company product.
3. **Marketing -** Advertises, promotes, ands sells the product.
4. **Human Resources -** Finds and hires people and handle personnel matters.
5. **Research -** Does product research and relates new discoveries to the firm's current or new products.



Management Levels

There are three management levels in most organizations:

1. Supervisors
   A. Manage and monitor the employees or workers.
   B. Responsible for operational matters (day-to-day operations).
   C. Example: production supervisor monitors materials needed to build a product.

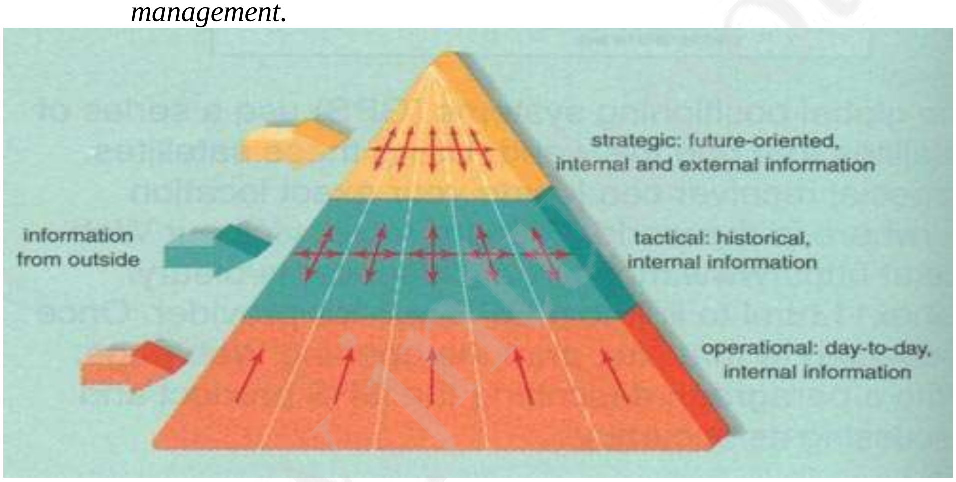
2. Middle Management
   A. Deal with control planning, tactical planning, and decision-making.
   B. Implement long-term goals of the organization.
   C. Example: regional sales manager sets sales goals for sales in several states.

3. Top Management
   A. Concerned with long-range planning (strategic planning)
   B. Need information to help them plan future growth and direction of the organization.

C. Example: vice president of marketing determines demand for current products and sales strategies for new products.

Information flow

a. Information must flow in different directions to support the different information needs of management.



b. Each level of management has different information needs.

1. Strategic Needs of Top-level managers
   - A. Information that reveals overall condition of the business in capsule form.
   - B. Information from all departments below and from outside the organization.
   - C. Information to plan for long-range events.
   - D. Example: planning for new facilities

2. Tactical Needs of Middle-level managers
   - A. Summarized information (weekly or monthly reports).

B. Information both horizontal and vertical across functional lines within the organization.
C. Historical, internal information to develop budgets and evaluate performances.
D. Example: developing production goals, concurring with top-level managers and supervisors

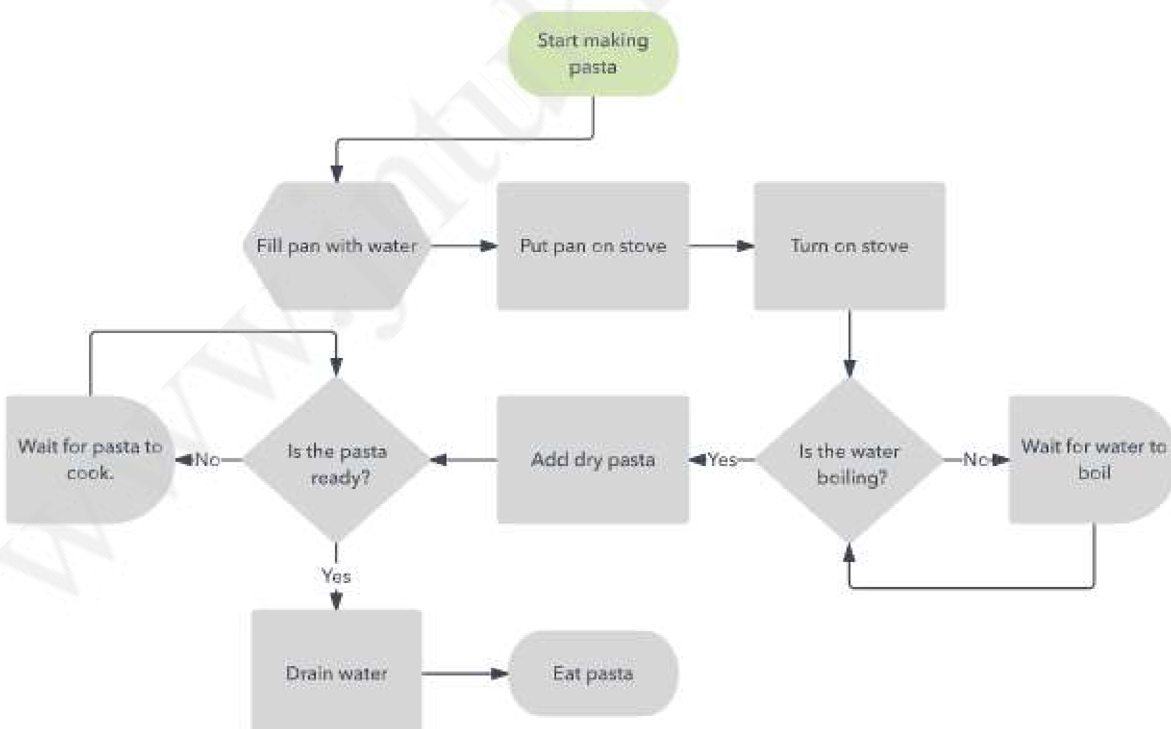
3. Operational Needs of Supervisors
    A. Detailed current day-to-day information.
    B. Information flow is primarily vertical.
    C. Communicate mainly with middle managers and workers beneath them.
    D. Day-to-day internal information to keep operations running smoothly.
    E. Example: monitoring current supplies, current inventory, and production output.

Strategy Analysis: Process Flow

A process map is a planning and management tool that visually describes the flow of work. Using process mapping software, process maps show a series of events that produce an end result. A process map is also called a flowchart, process flowchart, process chart, functional process chart, functional flowchart, process model, workflow diagram, business flow diagram or process flow diagram. It shows who and what is involved in a process and can be used in any business or organization and can reveal areas where a process should be improved.

Understanding processes

One of the purposes of process mapping is to gain better understanding of a process. The flowchart below is a good example of using process mapping to understand and improve a process. In this chart, the process is making pasta. Even though this is a very simplified process map example, many parts of business use similar diagrams to understand processes and improve process efficiency, such as operations, finance, supply chain, sales, marketing and accounting.



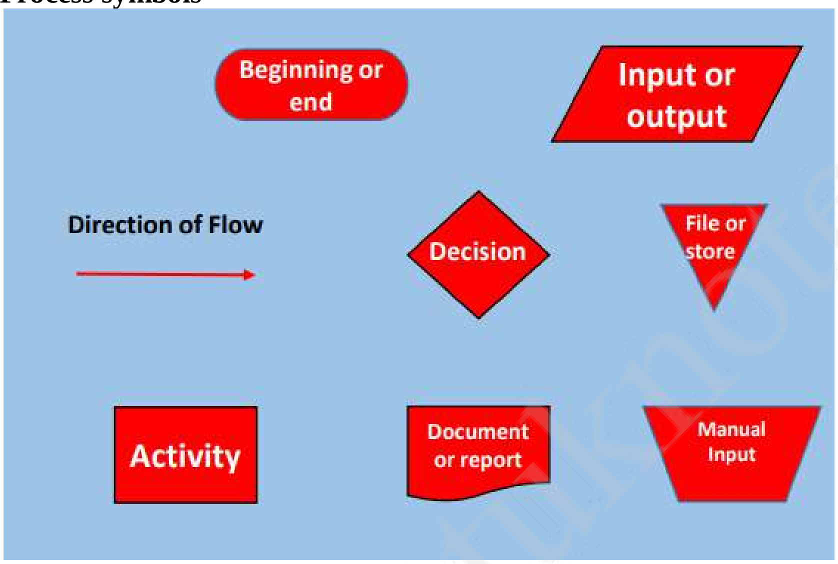
Steps Involved in Business Process Mapping

• Identify the process you want to document
• Gather information from process participants via interviews or observations
• Identify the start and end points of your process
• Break the process into distinct tasks and decision points

Basic Components of Business Process Mapping

• Process. The overall workflow from a starting point to its successful completion.
• Tasks or Activities. Something performed by a person or a system.
• Flows. This is indicated on the process map by connecting lines and arrows.
• Events. These are triggers that cause a process to begin, end, or may redirect a process to a different path.
• Gateways. Decisions that can change the path of the process depending on conditions or events.
• Participants. Specifically naming the people or systems that perform the tasks or activities.

Process symbols



Types of Process Maps

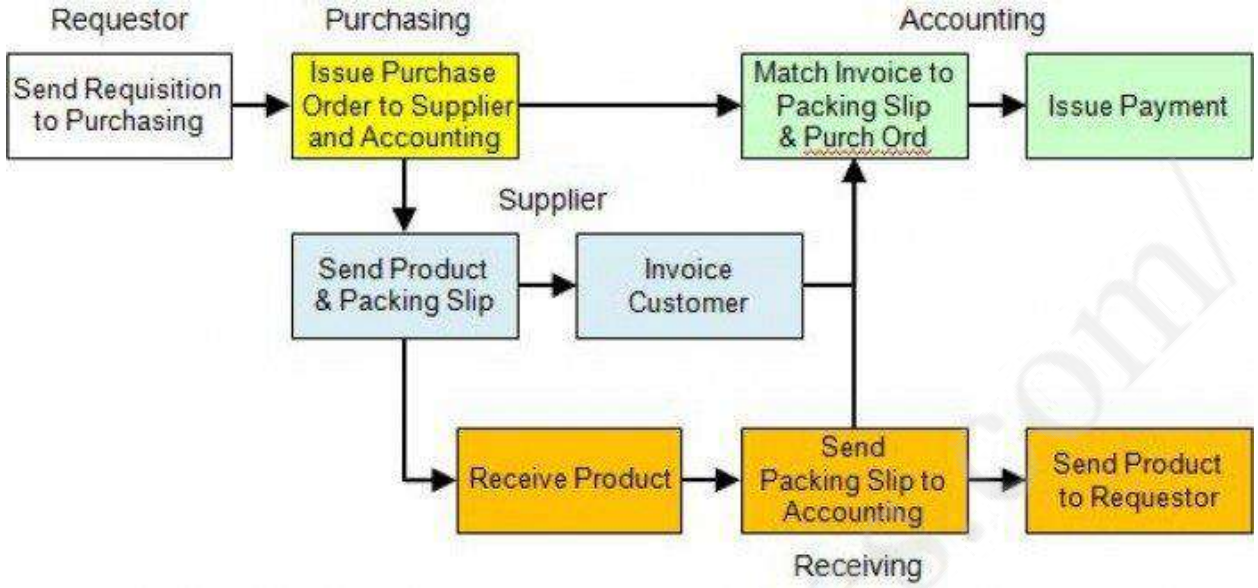
SIPOC is an acronym for Supplier – Inputs – Process – Outputs – Customer,
The importance of the SIPOC is that it shows, in very simple terms, what the process accomplishes while identifying the key players. The center contains the a few high-level process steps. The required inputs (and their providers) are listed to the left, and the key process outputs (and their recipients) are listed to the right. The SIPOC provides a focus for discussion of what the process is all about.

Supplier	Input	Process	Output	Customer
Requestor	Requisition	Purchasing	Purch Ord	Supplier

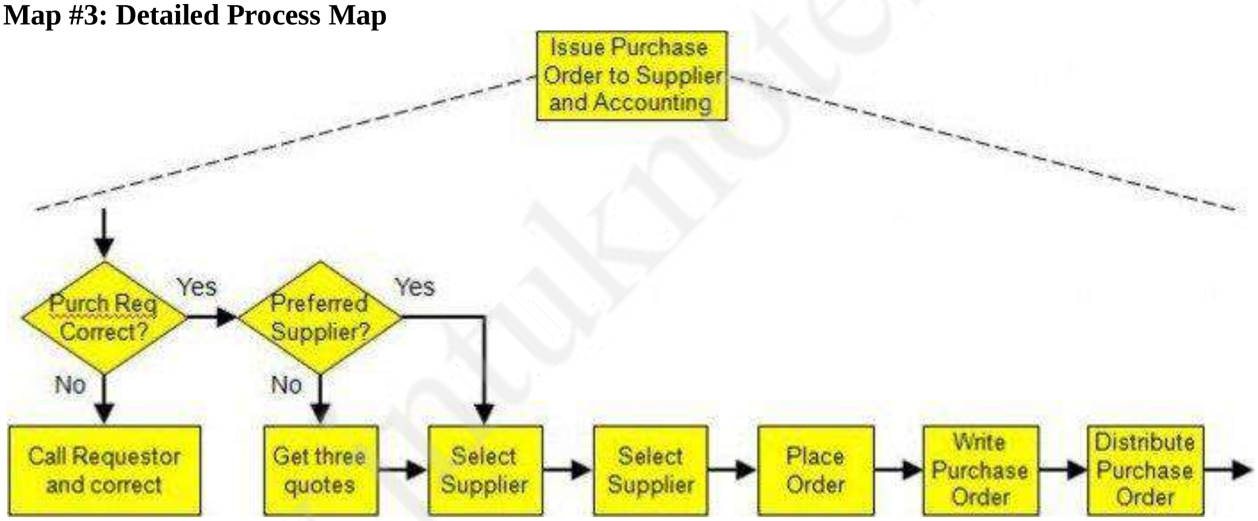
Map #2: High Level Process Map

High Level Process Maps show how the process works in just a few steps. The purpose is to provide quick and easy insights into what the process does, without getting into the details of how it's done. This can be useful when communicating to leadership and others who have no need (or interest) in seeing the details.
High Level Maps typically don't require a deep knowledge of the process, so you can often construct them with the assistance of managers. Think of the High Level Map as simply an expansion of the center

"process" from the SIPOC into five to ten more detailed boxes. This map shows where all the inputs go, and where all the outputs are created.



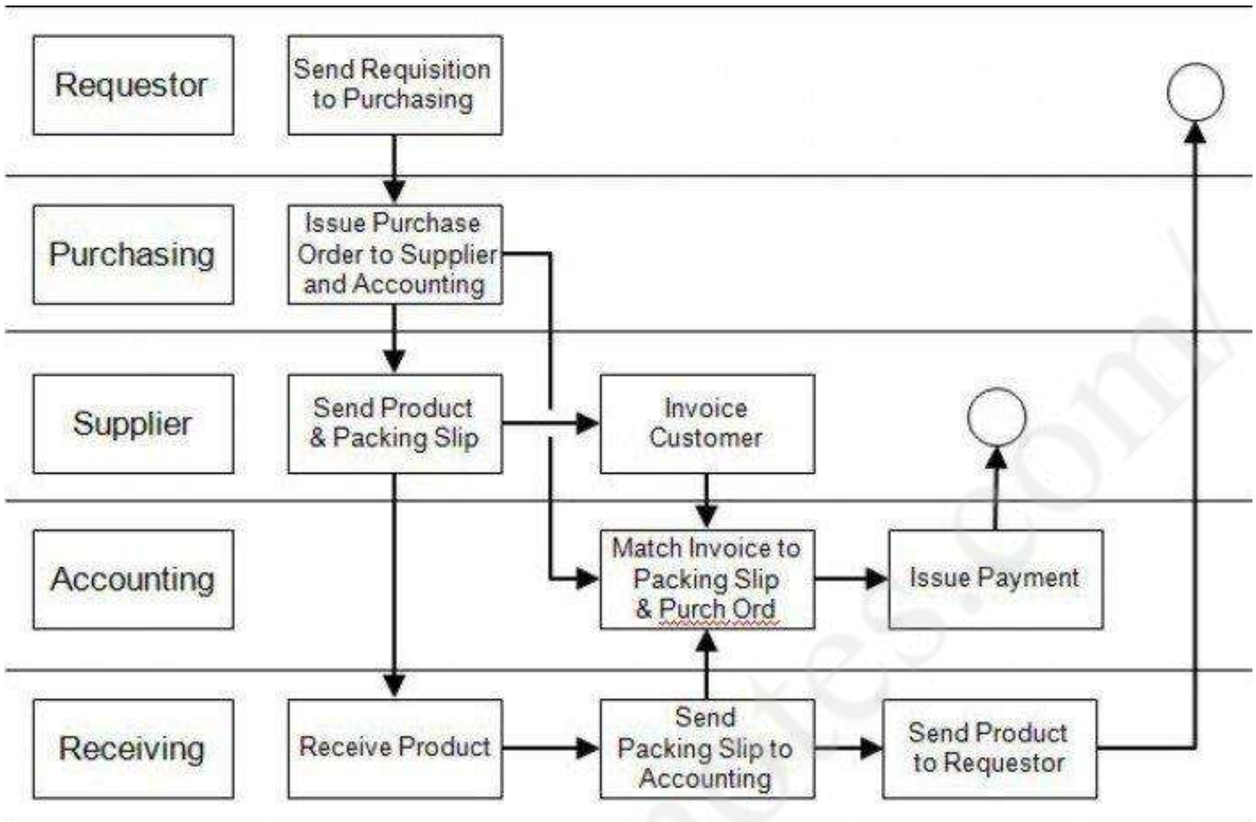
Map #3: Detailed Process Map



We don't normally need to see the entire process in detail, but there may be some parts of the process that require a **Detailed Process Map**. This is especially true if there are a number of problems with that step. In this example, we might be interested in exploring the Purchasing step. We simply consider the input to that step, identify what immediately happens with that input and then repeatedly ask the "what happens next?" question until we produce the output. If this provides the necessary level of detail, we can stop here. If, however, we need to know more about the "Get three quotes" part of the process, we could explode it into more detail. The key is *selectively* diving into the detail. It's a lot of work to create a detailed process map – you need to talk to the people who work the process in order to find out what really happens – managers often don't know the process at this level of detail. I prefer to start with a High Level Map and let the needs of the project dictate when to go into more detail and how far to dive down.

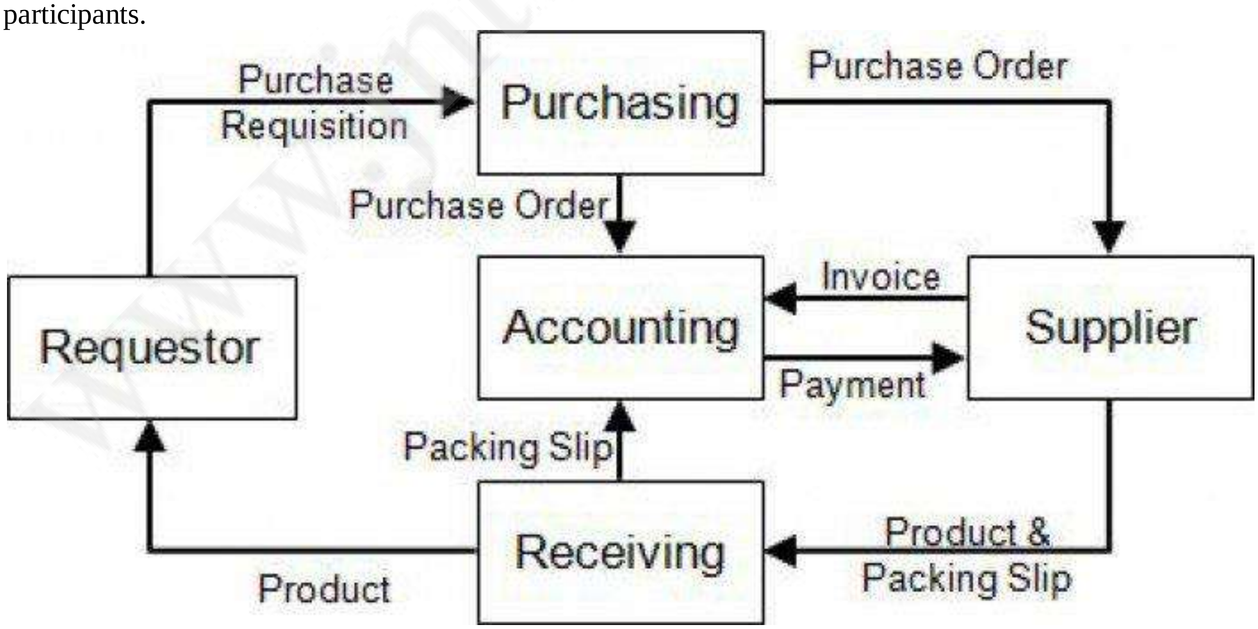
Map #4: Swimlane Map

Swimlane Maps separate the steps into lanes or channels according to who does the activity. If we have a process map where the participants have been identified by departmental colors, simply "sliding" the steps so those of the same color line up in a horizontal row, it becomes a Swimlane Map.



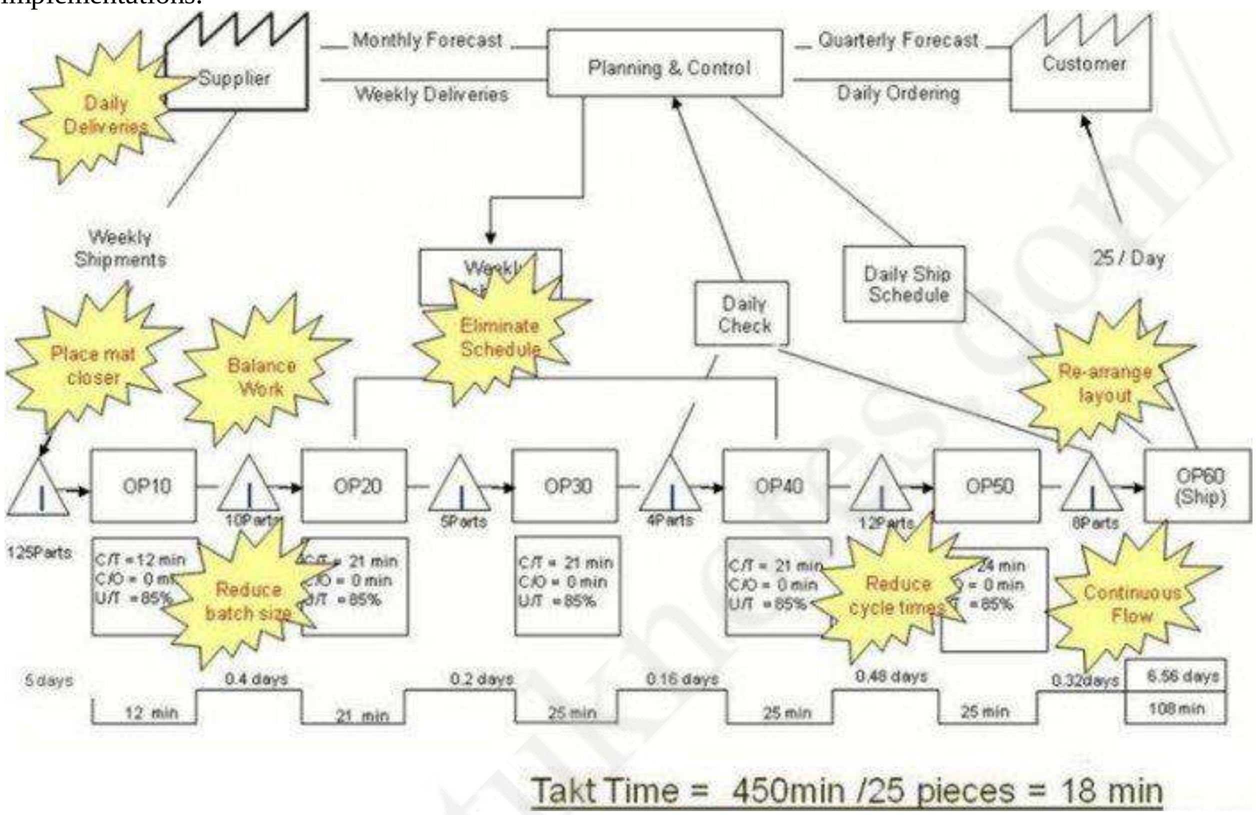
Map #5: Relationship Map

Relationship Maps are technically not process maps since they don't detail the work done, but they do show the participants and how materials, paper or information flows between them. This map was popularized by Rummler-Brache, and is not widely used, but I wanted to share it as an option. This map is useful when initially exploring the process, typically at a high level, to determine the identity of participants.



Map #6: Value Stream Map

Value Stream Maps are typically used in Lean applications where we are interested in either showing pull scheduling or opportunities to do pull scheduling. They are often detailed and difficult to read. However, they are rich with information that is useful when planning process improvements. Value Stream Maps are often used when planning a Lean implementation to display the current state of the process including material flows, information flows and other information important for Lean implementations.



Benefits of process mapping

Process mapping spotlights waste, streamlines work processes and builds understanding. Process mapping allows you to visually communicate the important details of a process rather than writing extensive directions.

Flowcharts and process maps are used to:

- Increase understanding of a process
- Analyze how a process could be improved
- Show others how a process is done
- Improve communication between individuals engaged in the same process
- Provide process documentation
- Plan projects

What is the Heuristic Method?

A heuristic method is an approach to finding a solution to a problem that originates from the ancient Greek word 'eurisko', meaning to 'find', 'search' or 'discover'. It is about using a practical method that doesn't necessarily need to be perfect. Heuristic methods speed up the process of reaching a satisfactory solution. Previous experiences with comparable problems are used that can concern problem situations for people, machines or abstract issues. One of the founders of heuristics is the Hungarian mathematician György (George) Pólya, who published a book about the subject in 1945 called 'How to Solve It'. He used four principles that form the basis for problem solving.

Heuristic method : Four principles

Pólya describes the following four principles in his book:

1. try to understand the problem
2. make a plan
3. carry out this plan
4. evaluate and adapt

First principle of the heuristic method- understand the problem

It's more difficult than it seems, because it seems obvious. In truth, people are hindered when it comes to finding an initially suitable approachto the problem. It can help to draw the problem and to look at it from another angle. What is the problem, what is happening, can the problem be explained in other words, is there enough information available, etc. Such questions can help with the first evaluation of a problem issue.

Second principle – make a plan

There are many ways to solve problems. This section is about choosing the right strategy that best fits the problem at hand. The reversed 'working backwards' can help with this; people assume to have a solution and use this as a starting point to work towards the problem. It can also be useful to make an overview of the possibilities, delete some of them immediately, work with comparisons, or to apply symmetry. Creativity comes into play here and will improve the ability to judge.

Third principle – carry out the plan

Once a strategy has been chosen, the plan can quickly be implemented. However, it is important to pay attention to time and be patient, because the solution will not simply appear. If the plan doesn't go anywhere, the advice is to throw it overboard and find a new way.

Fourth principle – evaluate and adapt

Take the time to carefully consider and reflect upon the work that's already been done. The things that are going well should be maintained, those leading to a lesser solution, should be adjusted. Some things simply work, while others simply don't.

Heuristics

There are many different heuristic methods, which Pólya also used. The most well-known heuristics are found below:

1. Dividing technique

The original problem is divided into smaller sub-problems that can be solved more easily. These sub-problems can be linked to each other and combined, which will eventually lead to the solving of the original problem.

2. Inductive method

This involves a problem that has already been solved, but is smaller than the original problem. Generalisation can be derived from the previously solved problem, which can help in solving the bigger, original problem.

3. Reduction method

Because problems are often larger than assumed and deal with different causes and factors, this method sets limits for the problem in advance. This reduces the leeway of the original problem, making it easier to solve.

4. Constructive method

This is about working on the problem step by step. The smallest solution is seen as a victory and from that point consecutive steps are taken. This way, the best choices keep being made, which will eventually lead to a successful end result.

5. Local search method

This is about the search for the most attainable solution to the problem. This solution is improved along the way. This method ends when improvement is no longer possible.

In a heuristic evaluation, usability experts review your site's interface and compare it against accepted usability principles. The analysis results in a list of potential usability issues.

Advantages and Disadvantages of Heuristics

A heuristic evaluation should not replace usability testing. Although the heuristics relate to criteria that affect your site's usability, the issues identified in a heuristic evaluation are different than those found in a usability test.

Advantages	**Disadvantages**
• It can provide some quick and relatively inexpensive feedback to designers. • You can obtain feedback early in the design process. • Assigning the correct heuristic can help suggest the best corrective measures to designers. • You can use it together with other usability testing methodologies. • You can conduct usability testing to further examine potential issues.	• It requires knowledge and experience to apply the heuristics effectively. • Trained usability experts are sometimes hard to find and can be expensive. • You should use multiple experts and aggregate their results. • The evaluation may identify more minor issues and fewer major issues.

Nielsen's Heuristics

Though many groups have developed heuristics, one of the best-known sources is the set developed by Nielsen's in 1994. Nielsen refined the list originally developed in 1990 by himself and Rolf Molich. Nielsen's Heuristics include:

- **Visibility of system status**: The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.
- **Match between system and the real world**: The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
- **User control and freedom**: Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.
- **Consistency and standards**: Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
- **Error prevention**: Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

- **Recognition rather than recall**: Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
- **Flexibility and efficiency of use**: Accelerators—unseen by the novice user—may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
- **Aesthetic and minimalist design**: Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
- **Help users recognize, diagnose, and recover from errors**: Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
- **Help and documentation**: Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

Functional Decomposition:

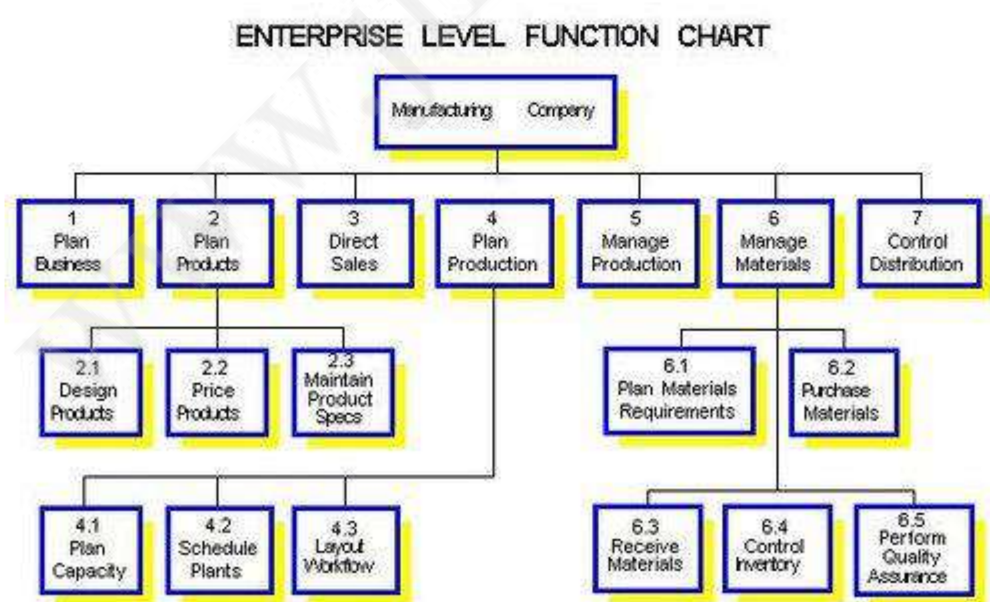
Use Functional Decomposition to:

- Hierarchically decompose a system into its functional components,
- Hierarchically decompose a business process into sub-processes,
- Provide a definition of all the business functions and sub-functions identified as system requirements.

Levels of Detail for Functional Decomposition

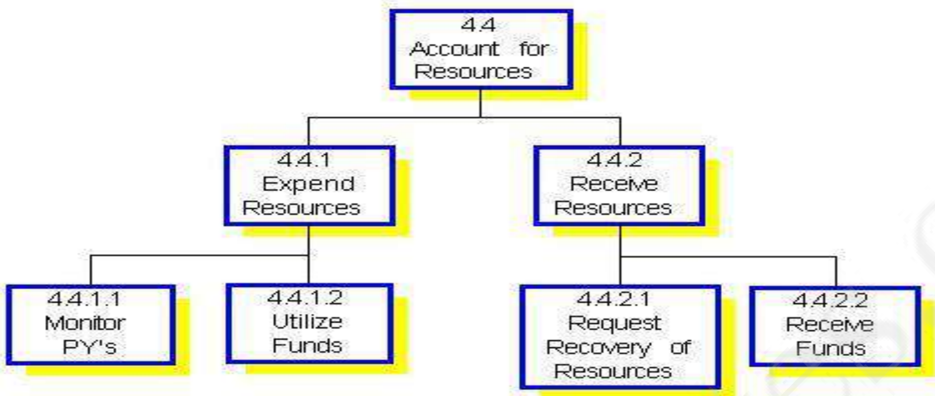
Enterprise Level of Detail

At the enterprise level , the root of the Function Chart may contain the name of the organization (or a major function or sub-function within an organization). The root is broken down into no more than three levels of detail. A brief description is provided for each function.



Conceptual Level of Detail
At the conceptual level, leaf level functions (i.e., lowest level functions) on the enterprise level chart within the context of the system are decomposed into the next level of detail. This level identifies the major business processes necessary to accomplish each function. Processes identified at this level typically correspond to application systems or sub-systems, for example, Sales, Finance, or Purchasing.

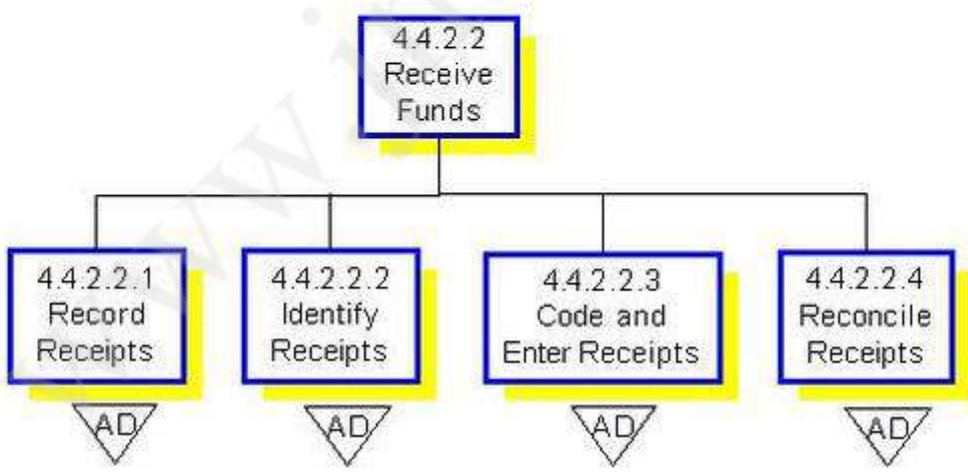
CONCEPTUAL LEVEL FUNCTION CHART



Functional Decomposition at the conceptual level of detail helps define the scope of a project.

Logical Level of Detail
At the logical level, the Function Chart decomposes processes into the lowest level of detail. Functional Decomposition at this level identifies all the processes within the scope of the project. The lowest level processes on the Function Chart can be documented using Action Diagrams, Structured English, or Pseudocode.

LOGICAL LEVEL FUNCTION CHART



AD = Action Diagram

Concepts of Coupling and Cohesion

The aim of Functional Decomposition is to identify functions which are highly cohesive and loosely coupled. This makes them conceptually and operationally independent and promotes more stable business systems.

Coupling is a measure of the degree to which two functions are interdependent. Loose coupling is good because changes to one function can be made with less impact on other functions, i.e., you do not have to know about other functions to make changes to the function being studied.

Cohesion is a measure of the strength of association of the processes within a function. High cohesion is good because highly cohesive functions that perform one well-defined objective are easier to understand and maintain.

Benefits of Good Functional Decomposition

A good Functional Decomposition helps the analysis in several ways:

- The simplicity of the structure and representation aids in understanding the breakdown of functions and processes.
- Specifying the precise requirements and features for each function becomes easier because the functions and processes are broken down into smaller units.
- The partitioning and independence of the functions localizes errors and minimizes system faults.
- It allows the customer to view and discuss the organization in a form that can be dealt with, i.e., as a collection of functions, rather than as a continuous process.

Problems of a Poor Functional Decomposition

Poor Functional Decomposition can hinder the project both now and in subsequent stages by:

- Hindering understanding of an organization's business when functions and processes overlap,
- Creating unnecessarily numerous, complex interfaces,
- Requiring extensive rework of other Process Modelling methods, such as Data Flow Diagrams, in later stages as detail problems emerge.

Aggregation:

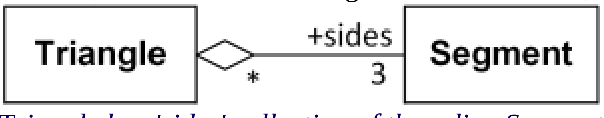
Design pattern: aggregation

Sometimes a class type really represents a collection of individual components. Although this pattern can be modeled by an ordinary association, its meaning becomes much clearer if we use the UML notation for an **aggregation**.aggregation is A special form of association that specifies a whole-part relationship between the aggregate (whole) and a component part.

Notation

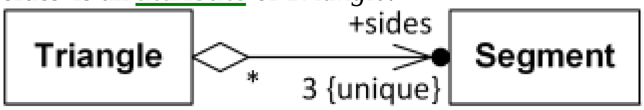
Shared aggregation is depicted as association decorated with a *hollow diamond* at the aggregate end of the association line. The diamond should be noticeably smaller than the diamond notation for N-ary associations.

Example below shows *Triangle* as an aggregate of exactly three line segments (sides). Multiplicity '*' of the *Triangle* association end means that each line *Segment* could be a part of several triangles, or might not belong to any triangle at all. Erasing specific *Triangle* instance does not mean that all or any segments will be deleted as well. (Note, that we named collection of three line Segments as 'sides', while usual UML convention is to use singular form, i.e. 'side', even for collections.)



Triangle has 'sides' collection of three line Segments.
Each line Segment could be part of none, one, or several triangles.

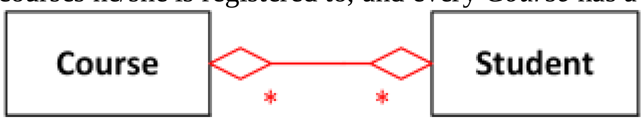
Shared aggregation could be depicted together with other association adornments such as **navigability** and **association end ownership**. In the example below line *Segment* is navigable from *Triangle*. Association end 'sides' is owned by *Triangle* (not by association itself), which means that 'sides' is an **attribute** of *Triangle*.



Triangle has 'sides' collection of three unique line Segments.
Line segments are navigable from Triangle.
Association end 'sides' is owned by Triangle, not by association itself.

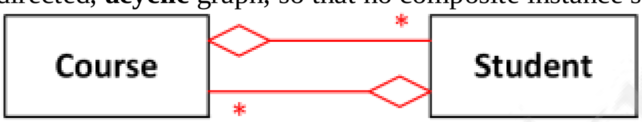
Mistakes

Aggregation is asymmetric relationship - only **one end** of association is allowed to be marked as shared or composite aggregation. Both UML 1.x and 2.x don't allow a diamond to be attached to both ends of association line. The reasoning behind the example below was that each *Student* instance has a list of courses he/she is registered to, and every *Course* has a list of students registered for that course.



Aggregation mistake - only one end of association can be marked as aggregation.

It will not help if we draw two separate aggregations as shown below. Aggregation links should form a directed, **acyclic** graph, so that no composite instance should be direct or indirect part of itself.



Aggregation mistake - no composite instance should be direct or indirect part of itself.

<u>Aggregation:</u> Selecting the data in group of records is called aggregation.

Data aggregation is the process of gathering data and presenting it in a summarized format. The data may be gathered from multiple data sources with the intent of combining these data sources into a summary for data analysis. Aggregation methods are types of calculations used to group attribute values into a metric for each dimension value. For example, for each country (each value of the Country dimension), you might want to retrieve the total value of transactions (the sum of the Sales Amount attribute).

Aggregation Method	Description
sum	Calculates the total value for the metric. You can use this aggregation method for numbers and durations. You cannot use this aggregation method for multi-value attributes.
average	Calculates the average value for the metric. You can use this aggregation method for numbers, dates, times, and durations. You cannot use this aggregation method for multi-value attributes.
median	Calculates the median value for the metric. You can use this aggregation method for numbers, dates, times, and durations. You cannot use this aggregation method for multi-value attributes.

Aggregation Method	Description
minimum	Selects the minimum value for the metric. You can use this aggregation method for numbers, dates, times, and durations. You cannot use this aggregation method for multi-value attributes.
maximum	Selects the maximum value for the metric. You can use this aggregation method for numbers, dates, times, and durations. You cannot use this aggregation method for multi-value attributes.
variance	Calculates the variance (square of the standard deviation) for the metric values. You can use this aggregation method for numbers, dates, times, and durations. You cannot use this aggregation method for multi-value attributes.
standard deviation	Calculates the standard deviation for the metric values. You can use this aggregation method for numbers, dates, times, and durations. You cannot use this aggregation method for multi-value attributes.
set	Instead of performing a calculation, creates a list of all of the unique values. You can use this aggregation method for any attribute.

To show how each of the aggregation methods work, we'll use the following data:

Country	Amount of Sale	Shipping Company
US	125.00	UPS
US	50.00	UPS
US	150.00	FedEx

Based on these values, the aggregation for Amount of Sale and Shipping Company for the US would be:

Aggregation Method	Amount of Sale (US)	Shipping Company (US)
Sum	325.00	Cannot be aggregated
Avg	108.33	Cannot be aggregated
Median	125.00	Cannot be aggregated
Min	50.00	Cannot be aggregated
Max	150.00	Cannot be aggregated

Aggregation Method	Amount of Sale (US)	Shipping Company (US)
Variance	2708.33	Cannot be aggregated
standard deviation	52.04	Cannot be aggregated
Set	125.00, 50.00, 150.00	UPS, FedEx
Number of records with values	3	3
Number of unique values	3	2

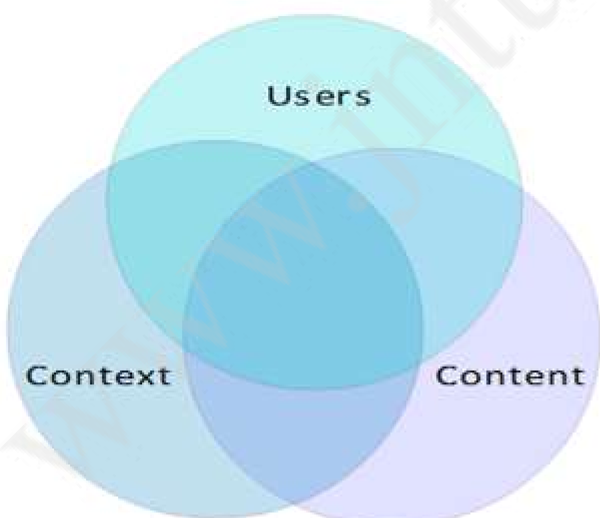
Information architecture:

Information architecture is the term used to describe the structure of a system, i.e the way information is grouped, the navigation methods and terminology used within the system.
An effective information architecture enables people to step logically through a system confident they are getting closer to the information they require.Information Architecture for the World Wide Web, note that the main components of IA:

- **Organization Schemes and Structures**: How you categorize and structure information
- **Labeling Systems**: How you represent information
- **Navigation Systems**: How users browse or move through information
- **Search Systems**: How users look for information

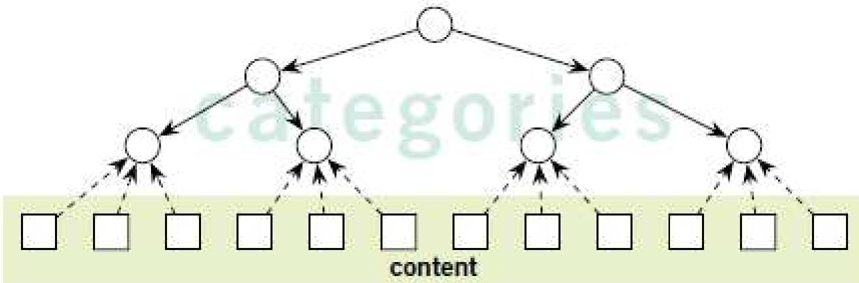
Each circle refers to:

- **Context**: business goals, funding, politics, culture, technology, resources, constraints
- **Content**: content objectives, document and data types, volume, existing structure, governance and ownership
- **Users**: audience, tasks, needs, information-seeking behavior, experience

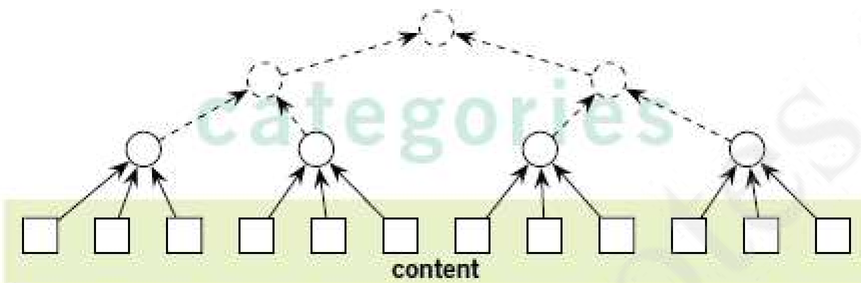


Styles of information architecture
There are two main approaches to defining an information architecture. These are:

- Top-down information **architectureThis involves developing a broad understanding of the business strategies and user needs, before defining the high level structure of site, and finally the detailed relationships between content.**



- A Bottom up approach to information architecture involves creating architecture directly from analysis of the content and functional requirements .We group items together into low-level categories and then group those into higher-level categories, building toward a structure that reflects our product objectives and user needs.



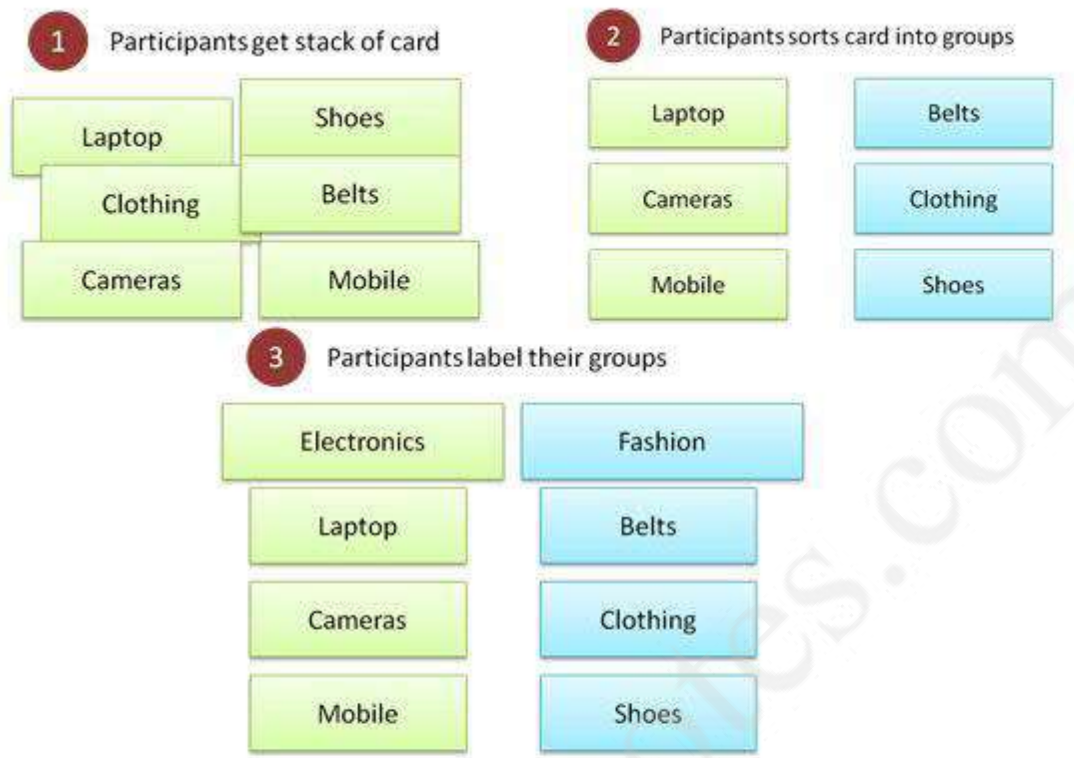
- **Deriving information architecture – Card Sorting**

Card sorting is a method used to help design or evaluate the information architecture of a site. In a card sorting session, participants organize topics into categories that make sense to them and they may also help you label these groups. Card sorting helps us gain valuable insight about the structure of data.

There are two common card sorting techniques:

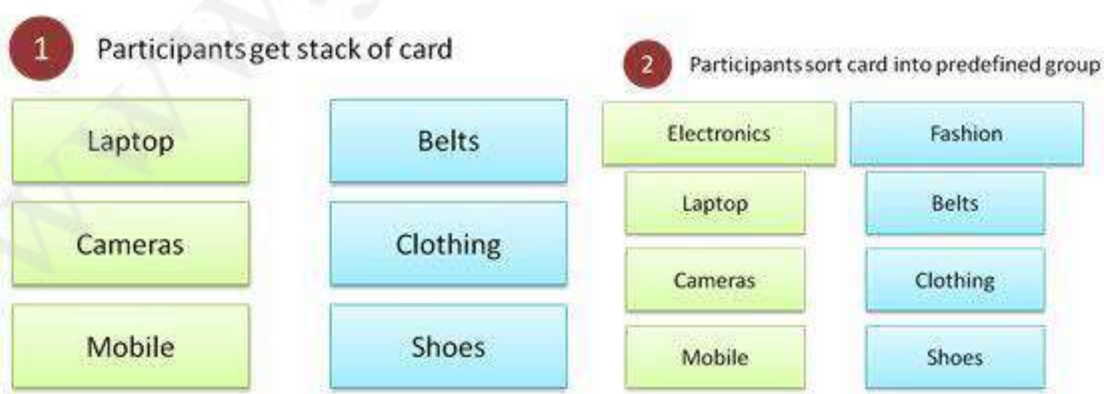
1. Open card Sort -

In open card sorting, each participant is given a stack of cards. The participant is then asked to group those cards together any way they want. Then they make labels for the groups they created.



When to Use Open Card Sorting – It's beneficial to use open card sort when you are starting with the new project. In this way you will not introduce your own biases into the grouping of items and will see the information organized from other people's perspectives.

Disadvantage of open card sorting – Sometimes it can be too vague as their might be many categories as participant has freedom to arrange and label the category .In this case it might be difficult to analyze the data and reached to any conclusion.
2. Closed Card Sort -
In closed card sorting, the researchers create the labels for the groups. Participants are given a stack of cards and are asked and are asked to put each card into a group.



Using Both Open Card Sorting and Closed Card Sorting
Conducting open card sort first help you determine category names for each group of content, and to understand the different ways participant can group the items. Then, after analyzing the results, you can conduct closed card sorting to validate the interpretation of the results.

UNIT - III:

Systems, Information and Decision Theory

Information Theory – Information Content and Redundancy – Classification and Compression – Summarizing and Filtering – Inferences and Uncertainty.

Information Theory

Information theory, a mathematical representation of the conditions and parameters affecting the transmission and processing of information.

Before information theory, remote communication was done using analogue signals. Sending a message involved turning it into varying pulses of voltage along a wire, which could be measured at the other end and interpreted back into words. This is generally fine for short distances but, if you want to send something across an ocean, it becomes unusable. Every metre that an analogue electrical signal travels along a wire, it gets weaker and suffers more from random fluctuations, known as noise, in the materials around it. You could boost the signal at the outset, of course, but this will have the unwanted effect of also boosting the noise.

Information theory helped to get over this problem. In it, Shannon defined the units of information, the smallest possible chunks that cannot be divided any further, into what he called "bits" (short for binary digit), strings of which can be used to encode any message. The most widely used digital code in modern electronics is based around bits that can each have only one of two values: 0 or 1.

This simple idea immediately improves the quality of communications. Convert your message, letter by letter, into a code made from 0s and 1s, then send this long string of digits down a wire – every 0 represented by a brief low-voltage signal and every 1 represented by a brief burst of high voltage. These signals will, of course, suffer from the same problems as an analogue signal, namely weakening and noise. But the digital signal has an advantage: the 0s and 1s are such obviously different states that, even after deterioration, their original state can be reconstructed far down the wire. An additional way to keep the digital message clean is to read it, using electronic devices, at intervals along its route and resend a clean repeat.

Shannon showed the true power of these bits, however, by putting them into a mathematical framework. His equation defines a quantity, H, which is known as Shannon entropy and can be thought of as a measure of the information in a message, measured in bits.

Examples:

Suppose we are watching cars going past on a highway. For simplicity, suppose 50% of the cars are black, 25% are white, 12.5% are red, and 12.5% are blue. Consider the flow of cars as an information source with four words: black, white, red, and blue. A simple way of encoding this source into binary symbols would be to associate each color with two bits, that is: black = 00, white = 01, red = 10, and blue = 11, an average of 2.00 bits per color.

A Better Code Using Information Theory

A better encoding can be constructed by allowing for the frequency of certain symbols, or words: black = 0, white = 10, red = 110, blue = 111.

How is this encoding better?

0.50 black x 1 bit = .500

0.25 white x 2 bits = .500

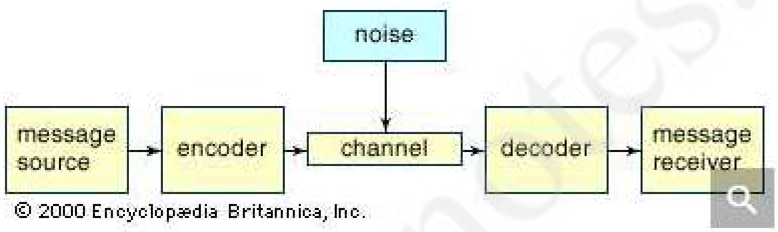
0.125 red x 3 bits = .375

0.125 blue x 3 bits = .375 Average-- 1.750 bits per car

Classical Information Theory

Shannon’s communication model

As the underpinning of his theory, Shannon developed a very simple, abstract model of communication, as shown in the figure. Because his model is abstract, it applies in many situations, which contributes to its broad scope and power



Shannon's communication modelConsider a simple telephone conversation: A person (message source) speaks into a telephone receiver (encoder), which converts the sound of the spoken word into an electrical signal. This electrical signal is then transmitted over telephone lines (channel) subject to interference (noise). When the signal reaches the telephone receiver (decoder) at the other end of the line it is converted back into vocal sounds. Finally, the recipient (message receiver) hears the original message.

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The first component of the model, the message source, is simply the entity that originally creates the message. The encoder is the object that connects the message to the actual physical signals that are being sent. The channel is the medium that carries the message. The channel might be wires, the air or space in the case of radio and television transmissions, or fibre-optic cable. Noise is anything that interferes with the transmission of a signal. The decoder is the object that converts the signal, as received, into a form that the message receiver can comprehend. The message receiver is the object that gets the message. Shannon’s theory deals primarily with the encoder, channel, noise source, and decoder.

The source S is a system with a range of possible states $s_1,\ldots,s_n$ usually called *letters*, whose respective probabilities of occurrence are $p(s_1),\ldots,p(s_n)$.[1] The amount of information generated at the source by the occurrence of s_i is defined as:

$$I(s_i) = \log(1/p(s_i)) = -\log p(s_i) \tag{1}$$

Since S produces sequences of states, usually called *messages*, the *entropy of the source S* is defined as the average amount of information produced at the source:

$$H(S) = \sum_{i=1}^{n} p(s_i)\log(1/p(s_i)) = -\sum_{i=1}^{n} p(s_i)\log p(s_i) \tag{2}$$

Analogously, the destination D is a system with a range of possible states $d_1,\ldots,d_m$, with respective probabilities $p(d_1),\ldots,p(d_m)$. The amount of information $I(d_j)$ received at the destination by the occurrence of d_j is defined as:

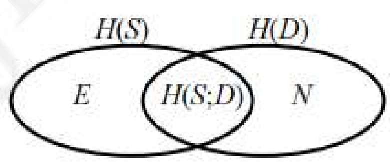
$$I(d_j) = \log(1/p(d_j)) = -\log p(d_j) \tag{3}$$

And the *entropy of the destination D* is defined as the average amount of information received at the destination:

$$H(D) = \sum_{j=1}^{m} p(d_j)\log(1/p(d_j)) = -\sum_{j=1}^{m} p(d_j)\log p(d_j) \tag{4}$$

\

The relationship between the entropies of the source $H(S)$ and of the destination $H(D)$ can be represented in the following diagram:



where:

- $H(S;D)$ is the *mutual information*: the average amount of information generated at the source S and received at the destination D.
- E is the *equivocation*: the average amount of information generated at S but not received at D.
- N is the *noise*: the average amount of information received at D but not generated at S.

As the diagram clearly shows, the mutual information can be computed as:

$$H(S;D) = H(S) - E = H(D) - N \qquad (5)$$

Applications Of Information Theory

Data compression

Shannon's concept of entropy (a measure of the maximum possible efficiency of any encoding scheme) can be used to determine the maximum theoretical compression for a given message alphabet. In particular, if the entropy is less than the average length of an encoding, compression is possible.

Error-correcting and error-detecting codes

Shannon's work in the area of discrete, noisy communication pointed out the possibility of constructing error-correcting codes. Error-correcting codes add extra bits to help correct errors and thus operate in the opposite direction from compression. Error-detecting codes, on the other hand, indicate that an error has occurred but do not automatically correct the error.

Cryptology

Cryptology is the science of secure communication. It concerns both cryptanalysis, the study of how encrypted information is revealed (or decrypted) when the secret "key" is unknown, and cryptography, the study of how information is concealed and encrypted in the first place.

Shannon's analysis of communication codes led him to apply the mathematical tools of information theory to cryptography in "Communication Theory of Secrecy Systems" (1949). In particular, he began his analysis by noting that simple transposition ciphers—such as those obtained by permuting the letters in the alphabet—do not affect the entropy because they merely relabel the characters in his formula without changing their associated probabilities.

Linguistics

While information theory has been most helpful in the design of more efficient telecommunication systems, it has also motivated linguistic studies of the relative frequencies of words, the length of words, and the speed of reading.

information theory provides a means for measuring redundancy or efficiency of symbolic representation within a given language. For example, if English letters occurred with equal regularity (ignoring the distinction between uppercase and lowercase letters), the expected entropy of an average sample of English text would be $\log_2(26)$, which is approximately 4.7

Information Content

Shannon, in fact, defined entropy as a measure of the average information content associated with a random outcome.

Measures of Information

Information on a computer is represented by binary bit strings. Decimal numbers can be represented using the following encoding. The position of the binary digit

Bit 1 ($2^3 = 8$)	Bit 2 ($2^2 = 4$)	Bit 3 ($2^1 = 2$)	Bit 4 ($2^0 = 1$)	Decimal
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
.	.	.	.	.
.	.	.	.	.
0	1	1	1	14
1	1	1	1	15

Table 4.1: *Binary encoding*

indicates its decimal equivalent such that if there are N bits the ith bit represents the decimal number 2^{N-i}. Bit 1 is referred to as the most significant bit and bit N as the least significant bit. To encode M different messages requires $\log_2 M$ bits.

Entropy

The table below shows the probability of occurrence $p(x_i)$ (to two decimal places) of selected letters x_i in the English alphabet. These statistics were taken from Mackay's book on Information Theory [36]. The table also shows the *information content* of a

x_i	$p(x_i)$	$h(x_i)$
a	0.06	4.1
e	0.09	3.5
j	0.00	10.7
q	0.01	10.3
t	0.07	3.8
z	0.00	10.4

Table 4.2: *Probability and Information content of letters*

letter

$$h(x_i) = \log \frac{1}{p(x_i)} \tag{4.1}$$

which is a measure of surprise;
The entropy is the average information content

$$H(x) = \sum_{i=1}^{M} p(x_i) h(x_i) \tag{4.2}$$

where M is the number of discrete values that x_i can take. It is usually written as

$$H(x) = -\sum_{i=1}^{M} p(x_i) \log p(x_i) \tag{4.3}$$

with the convention that $0 \log 1/0 = 0$. Entropy measures uncertainty.

Entropy is maximised for a uniform distribution $p(x_i) = 1/M$. The resulting entropy is $H(x) = log_2 M$ which is the number of binary bits required to represent M different messages (first section). For $M = 2$, for example, the maximum entropy distribution is given by $p(x_1) = p(x_2) = 0.5$ (eg. an unbiased coin; biased coins have lower entropy).

This is however, the information content due to considering just the probability of occurence of letters. But, in language, our expectation of what the next letter will be is determined by what the previous letters have been. To measure this we need the concept of joint entropy. Because H(x) is the entropy of a 1-dimensional variable it is sometimes called the scalar entropy, to differentiate it from the joint entropy.

Joint Entropy

Table 2 shows the probability of occurence (to three decimal places) of selected pairs of letters x_i and y_i where x_i is followed by y_i. This is called the joint probability $p(x_i, y_i)$. The table also shows the joint information content

x_i	y_j	$p(x_i, y_j)$	$h(x_i, y_j)$
t	h	0.037	4.76
t	s	0.000	13.29
t	r	0.012	6.38

Table 4.3: *Probability and Information content of pairs of letters*

$$h(x_i, y_j) = \log \frac{1}{p(x_i, y_j)} \tag{4.4}$$

The average joint information content is given by the *joint entropy*

$$H(x, y) = -\sum_{i=1}^{M} \sum_{j=1}^{M} p(x_i, y_j) \log p(x_i, y_j) \tag{4.5}$$

If we fix x to, say x_i then the probability of y taking on a particular value, say y_j, is given by the *conditional probability*

$$p(y = y_j | x = x_i) = \frac{p(x = x_i, y = y_j)}{p(x = x_i)} \tag{4.6}$$

For example, if $x_i = t$ and $y_j = h$ then the joint probability $p(x_i, y_j)$ is just the probability of occurrence of the pair (which from table 2 is 0.037). The conditional probability $p(y_j|x_i)$, however, says that, given we've seen the letter t, what's the probability that the next letter will be h (which from tables 1 and 2 is $0.037/0.07 = 0.53$). Re-arranging the above relationship (and dropping the $y = y_j$ notation) gives

$$p(x, y) = p(y|x)p(x) \tag{4.7}$$

Now if y does *not* depend on x then $p(y|x) = p(y)$. Hence, for independent variables, we have

$$p(x, y) = p(y)p(x) \tag{4.8}$$

This means that, for independent variables, the joint entropy is the sum of the individual (or *scalar* entropies)

$$H(x, y) = H(x) + H(y) \tag{4.9}$$

Relative Entropy

The *relative entropy* or *Kullback-Liebler Divergence* between a distribution $q(x)$ and a distribution $p(x)$ is defined as

$$D[q||p] = \sum_x q(x) \log \frac{q(x)}{p(x)} \tag{4.10}$$

Mutual Information

The *mutual information* is defined [12] as the relative entropy between the joint distribution and the product of individual distributions

$$I(x; y) = D[p(X, Y)||p(X)p(Y)] \tag{4.14}$$

Substuting these distributions into 4.10 allows us to express the mutual information as the difference between the sum of the individual entropies and the joint entropy

$$I(x; y) = H(x) + H(y) - H(x, y) \tag{4.15}$$

Therefore if x and y are independent the mutual information is zero. More generally, $I(x; y)$ is a measure of the *dependence* between variables and this dependence will be captured if the underlying relationship is linear *or* nonlinear. This is to be contrasted with Pearsons correlation coefficient, which measures only linear correlation (see first lecture).

Examples:

Suppose we are watching cars going past on a highway. For simplicity, suppose 50% of the cars are black, 25% are white, 12.5% are red, and 12.5% are blue. Consider the flow of cars as an information source with four words: black, white, red, and blue. A simple way of encoding this source into binary symbols would be to associate each color with two bits, that is: black = 00, white = 01, red = 10, and blue = 11, an average of 2.00 bits per color.

A Better Code Using Information Theory

A better encoding can be constructed by allowing for the frequency of certain symbols, or words: black = 0, white = 10, red = 110, blue = 111.

How is this encoding better?

0.50 black x 1 bit = .500

0.25 white x 2 bits = .500

0.125 red x 3 bits = .375

0.125 blue x 3 bits = .375 Average-- 1.750 bits per car

Properties of Shannon's information entropy

We write $H(X)$ as $H_n(p_1,\ldots,p_n)$. The Shannon entropy satisfies the following properties:

- For any n, $H_n(p_1,\ldots,p_n)$ is a continuous and symmetric function on variables $p_1, p_2,\ldots,p_n$.
- Event of probability zero does not contribute to the entropy, i.e. for any n,

$$H_{n+1}(p_1, \ldots, p_n, 0) = H_n(p_1, \ldots, p_n).$$

- Entropy is maximized when the probability distribution is uniform. For all n,

$$H_n(p_1, \ldots, p_n) \leq H_n\left(\frac{1}{n}, \ldots, \frac{1}{n}\right).$$

Redundancy

Redundancy in information theory is the number of bits used to transmit a message minus the number of bits of actual information in the message. Informally, it is the amount of wasted "space" used to transmit certain data. Data compression is a way to reduce or eliminate unwanted redundancy, while checksums are a way of adding desired redundancy for purposes of error detection when communicating over a noisy channel of limited capacity.

Entropy and Redundancy

Information theory seeks to understand how much information is contained in a given source. One of the base measures in information theory is entropy. Roughly speaking, the entropy of a source represents how much it can be compressed by an optimal lossless algorithm. It is a measure of information.

The entropy H of a given source X is defined as

H(X) = - ∑ p(x) log(p(x))

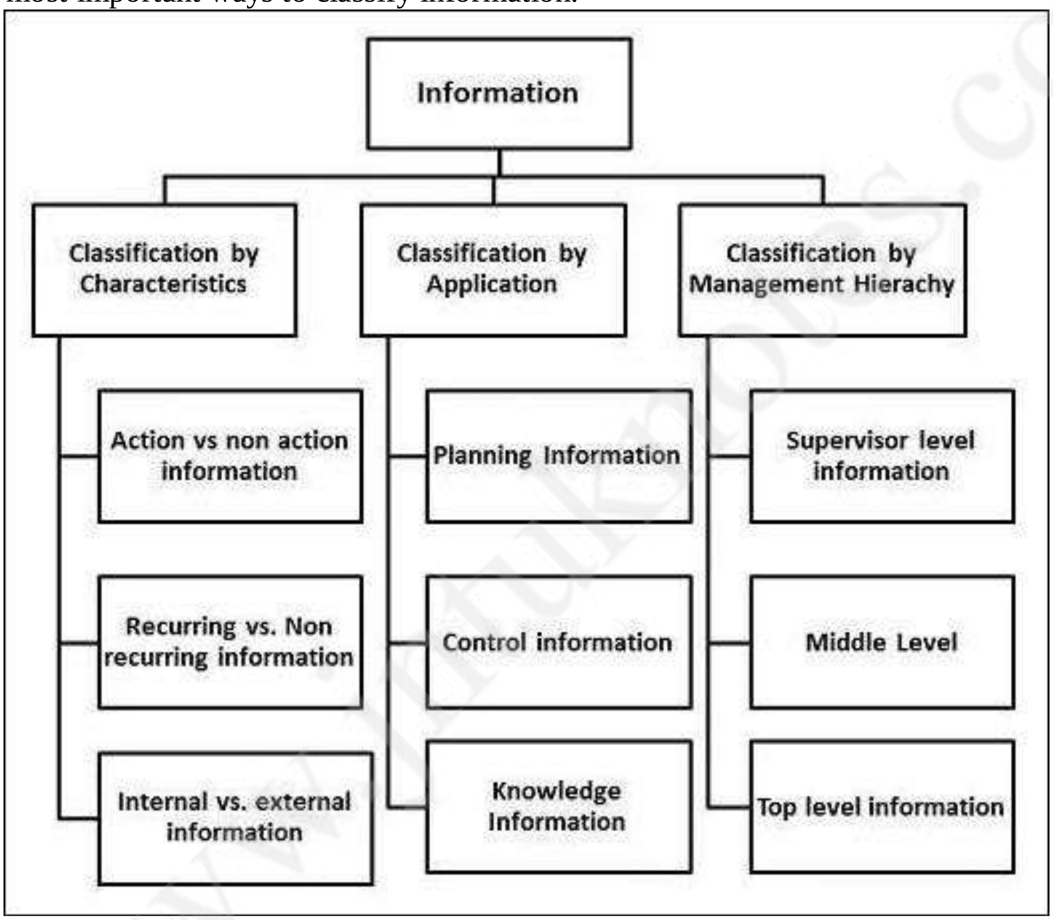
where the source X is modeled as a random variable, and p(x) is the probability of an element $x \in X$ occuring.

The entropy of a given source is affected by the number of elements in X. Thus a normalized measure, redundancy, is better for comparing multiple sources. Redundancy compares the actual entropy of a source to its theoretical maximum entropy.

$R(X) = 1 - H_{actual}(X)/H_{max}(X)$

The higher the redundancy, the more a given source can be compressed. See the course text, p224, or the lecture notes for more information.

Information can be classified in a number of ways and in this chapter, you will learn two of the most important ways to classify information.



Classification by Characteristic

Based on Anthony's classification of Management, information used in business for decision-making is generally categorized into three types −

- **Strategic Information** − Strategic information is concerned with long term policy decisions that defines the objectives of a business and checks how well these objectives are met. For example, acquiring a new plant, a new product, diversification of business etc, comes under strategic information.
- **Tactical Information** − Tactical information is concerned with the information needed for exercising control over business resources, like budgeting, quality control, service level, inventory level, productivity level etc.

- **Operational Information** − Operational information is concerned with plant/business level information and is used to ensure proper conduction of specific operational tasks as planned/intended. Various operator specific, machine specific and shift specific jobs for quality control checks comes under this category.

Classification by Application

In terms of applications, information can be categorized as −

- **Planning Information** − These are the information needed for establishing standard norms and specifications in an organization. This information is used in strategic, tactical, and operation planning of any activity. Examples of such information are time standards, design standards.
- **Control Information** − This information is needed for establishing control over all business activities through feedback mechanism. This information is used for controlling attainment, nature and utilization of important processes in a system. When such information reflects a deviation from the established standards, the system should induce a decision or an action leading to control.
- **Knowledge Information** − Knowledge is defined as "information about information". Knowledge information is acquired through experience and learning, and collected from archival data and research studies.
- **Organizational Information** − Organizational information deals with an organization's environment, culture in the light of its objectives. Karl Weick's Organizational Information Theory emphasizes that an organization reduces its equivocality or uncertainty by collecting, managing and using these information prudently. This information is used by everybody in the organization; examples of such information are employee and payroll information.
- **Functional/Operational Information** − This is operation specific information. For example, daily schedules in a manufacturing plant that refers to the detailed assignment of jobs to machines or machines to operators. In a service oriented business, it would be the duty roster of various personnel. This information is mostly internal to the organization.
- **Database Information** − Database information construes large quantities of information that has multiple usage and application. Such information is stored, retrieved and managed to create databases. For example, material specification or supplier information is stored for multiple users.

Data compression

In computer science and information theory, **data compression**, **source coding**,[1] or **bit-rate reduction** involves encoding information using fewer bits than the original representation.Compression is useful because it helps reduce the consumption of resources such as data space or transmission capacity.

When transmitting digital data, we find that frequently we can't send our information as quickly as we would like. Specific limits, such as Shannon's Channel Capacity, restrict the amount of digital information that can be transmitted over a given channel. Therefore, if we want to transmit more data, we need to find a way to make our data *smaller*.

To make data smaller, we implement one of a number of techniques known as data compression. There are a number of different compression algorithms, but they can all be broken down into two categories: Lossless algorithms, and lossy algorithms.

The fundamental function of a compression is to remove redundancy, where redundancy is all that could be removed or expressed in a different way, whilst not removing it's meaning.

Lossy Algorithms

Lossy algorithms are techniques that can be used to transmit a "pretty good" version of the data. With a lossy algorithm, there is always going to be a certain amount of data lost in the conversion. Lossy algorithms provide much higher compression rates then lossless algorithms, but the downfall is that information must be lost to attain those high rates. An example of a lossy compression algorithm is .jpeg image files, or mp3 music files. If the lossy algorithm is good enough, the loss might not be noticeable by the recipient.

Lossless Algorithms

Lossless algorithms decrease the size of a given signal, while at the same time not losing any information from the original. For this reason, Lossless compression algorithms are preferable to lossy algorithms, especially when the data needs to arrive at the recipient intact. Examples of lossless compression algorithms are ZIP files, and GIF images.

Run-Length Encoding

Run-length encoding (RLE) is probably one of the best known compression techniques. Here is how it works: Let's assume we have some input data: 'aaaabbbc' Now RLE compresses this by expressing the amount of times each symbol occurs, if it occurs more than 2 times. This 'compresses' to '4a3bc' which means as much as 4 x a, 3 x b, 1 x c. We don't express a data item explicitly if it occurs twice or just once. We would just lose space.

Variable-Length Coding

Assuming that some of the symbols are more likely than others (and assuming we know the respective probabilities of occurrence), the key idea to obtaining a more efficient coding is to use variable-length coding. That is, we assign shorter codewords to the more frequently occurring symbols and longer codewords to the symbols that occur infrequently. The standard coding that uses the same number of bits for each codeword is called fixed-length coding.

Consider four symbols s1, s2, s3, s4. With the standard (fixed-length) encoding we would need 2 bits/symbol – e.g., we might assign the codewords 00, 01, 10, 11, respectively.

Suppose we know that the probabilities for the symbols are 1/2 for s1, 1/4 for s2, and 1/8 each for s3 and s4. How might we exploit this knowledge? Suppose we assign the codewords 0, 10, 110, and 111 for s1, s2, s3, and s4, respectively.

$(1)(1/2) + (2)(1/4) + (3)(1/8) + (3)(1/8) = 1.75$. Thus, on average we only need 1.75 bits/symbol instead of 2 bits/symbol.

Huffman Coding

Huffman coding is a simple and systematic way to design good variable-length codes given the probabilities of the symbols.Huffman coding is a very powerful compression technique that can be used as an optimal lossless encoding technique. It tries to assign most recurring words(data) with fewer number bits and least recurring words with a greater number of bits.

The Huffman coding algorithm can be summarized as follows:

1. Think of the p_i as the leaf nodes of a tree. In constructing a Huffman code by hand it's sometimes useful to sort the p_i in decreasing order.

2. Starting with the leaf nodes, construct a tree as follows. Repeatedly join two nodes with the smallest probabilities to form a new node with the sum of the probabilities just joined. Assign a 0 to one branch and a 1 to the other branch. In constructing Huffman codes by hand, it's often helpful to do this assignment in a systematic way, such as always assigning 0 to the branch on the same side.

3. The codeword for each symbol is given by the sequence of 0's and 1's starting *from* the root node and leading *to* the leaf node corresponding to the symbol.

The order of reading off the o's and 1's in constructing the codewords is important. If the order is reversed, the resulting code will generally not be instantaneous.

Example 8.1 (A Simple Huffman Code) Consider a source with symbols s1, s2, s3, s4 with probabilities 1/2, 1/4, 1/8, 1/8, respectively. The Huffman code is constructed as shown in Figure 8.1.

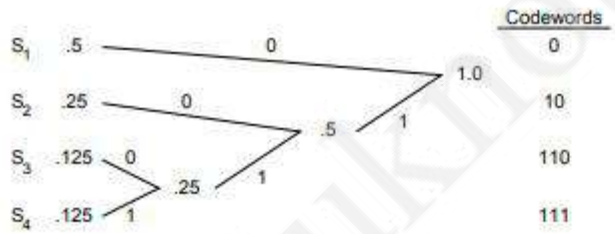


Figure 8.1: Construction of simple Huffman code with 4 symbols.

From the tree constructed, we can read off the codewords. For example, the codeword for s_2 is found by starting at the root node and following the branches labeled 1 then 0 to arrive at s_2. Therefore, the codeword for s_2 is 10.

The average number of bits per symbol for this code is

$$\begin{aligned}\text{average length} &= (1)\left(\frac{1}{2}\right)+(2)\left(\frac{1}{4}\right)+(3)\left(\frac{1}{8}\right)+(3)\left(\frac{1}{8}\right)\\ &= 1.75 \ \ \text{bits/symbol}\end{aligned}$$

Note that a fixed length code would require 2 bits/symbol.

What is best we can do for the given source? The answer is provided by the entropy, which is given by

$$\begin{aligned}H &= \frac{1}{2}\log_2 2+\frac{1}{4}\log_2 4+\frac{1}{8}\log_2 8+\frac{1}{8}\log_2 8\\ &= \frac{1}{2}+\frac{1}{2}+\frac{3}{8}+\frac{3}{8}\\ &= 1.75\end{aligned}$$

In the example above, the rate of the Huffman code is exactly the entropy,
Example 8.2 (A Slightly More Involved Huffman Code) Consider a source with eight symbols s1, . . . , s8 with probabilities 0.25, 0.21, 0.15, 0.14, 0.0625, 0.625, 0.625, 0.625, respectively. The Huffman code is constructed as shown in Figure 8.2.

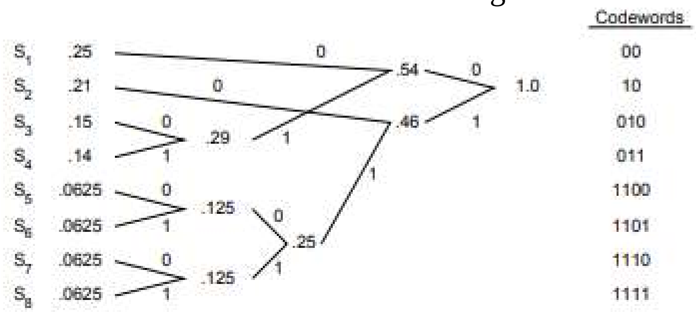


Figure 8.2: A slightly more involved Huffman code with 8 symbols.

Note that in this example, at the stage when we combined the node with probability 0.21 (corresponding to s_2) with the node with probability 0.25 (leading to s_5, s_6, s_7, s_8), we could have instead combined s_2 with s_1 since the node corresponding to s_1 also has probability 0.25. Whenever there is more than one choice, they are all acceptable and lead to valid Huffman codes. Of course, the specific codewords and even the lengths of the codewords may be different for the different choices. However, all will result in the same average codeword length. The average number of bits per symbol for this code is

$$\begin{aligned} \text{average length} &= (2)(0.25+0.21)+(3)(0.15+0.14) \\ &\quad +(4)(0.0625+0.0625+0.0625+0.0625) \\ &= 2.79 \ \text{bits/symbol} \end{aligned}$$

Note that a fixed length code would require 3 bits/symbol.

For this source the entropy is given by

$$\begin{aligned} H &= 0.25\log_2\left(\frac{1}{0.25}\right)+0.21\log_2\left(\frac{1}{0.21}\right)+0.15\log_2\left(\frac{1}{0.15}\right) \\ &\quad +0.14\log_2\left(\frac{1}{0.14}\right)+(4)(0.0625)\log_2\left(\frac{1}{0.0625}\right) \\ &\approx 2.78 \end{aligned}$$

■

In this example, the average length of the Huffman code is close, but not equal, to the entropy of the source.

Summarization:

Automatic summarization is the process of shortening a set of data computationally, to create a subset (a summary) that represents the most important or relevant information within the original content.

In addition to text, images and videos can also be summarized. Text summarization finds the most informative sentences in a document; image summarization finds the most representative images within an image collection[citation needed]; video summarization extracts the most important frames from the video content.[1]

here are broadly two types of extractive summarization tasks depending on what the summarization program focuses on. The first is *generic summarization*, which focuses on obtaining a generic summary or abstract of the collection (whether documents, or sets of images, or videos, news stories etc.). The second is *query relevant summarization*, sometimes called *query-based summarization*, which summarizes objects specific to a query. Summarization systems are able to create both query relevant text summaries and generic machine-generated summaries depending on what the user needs.

An example of a summarization problem is document summarization, which attempts to automatically produce an abstract from a given document. Sometimes one might be interested in generating a summary from a single source document, while others can use multiple source documents (for example, a cluster of articles on the same topic). This problem is called multi-document summarization. A related application is summarizing news articles. Imagine a system, which automatically pulls together news articles on a given topic (from the web), and concisely represents the latest news as a summary.

Image collection summarization is another application example of automatic summarization. It consists in selecting a representative set of images from a larger set of images.[3] A summary in this context is useful to show the most representative images of results in an image collection exploration system. Video summarization is a related domain, where the system automatically creates a trailer of a long video. This also has applications in consumer or personal videos, where one might want to skip the boring or repetitive actions. Similarly, in surveillance videos, one would want to extract important and suspicious activity, while ignoring all the boring and redundant frames captured.

At a very high level, summarization algorithms try to find subsets of objects (like set of sentences, or a set of images), which cover information of the entire set. This is also called the *core-set*. These algorithms model notions like diversity, coverage, information and representativeness of the summary. Query based summarization techniques, additionally model for relevance of the summary with the query. Some techniques and algorithms which naturally model summarization problems are TextRank and PageRank, Submodular set function, Determinantal point process, maximal marginal relevance (MMR) etc.

Text summarization refers to the technique of shortening long pieces of text. The intention is to create a coherent and fluent summary having only the main points outlined in the document.

applying text summarization reduces reading time, accelerates the process of researching for information, and increases the amount of information that can fit in an area.

There are two main types of how to summarize text in NLP:

- **Extraction-based summarization**

The extractive text summarization technique involves pulling keyphrases from the source document and combining them to make a summary. The extraction is made according to the defined metric without making any changes to the texts.

Here is an example:

Source text: ***Joseph and Mary*** *rode on a donkey to* ***attend*** *the annual* ***event*** *in* ***Jerusalem****. In the city,* ***Mary*** *gave* ***birth*** *to a child named* ***Jesus****.*

Extractive summary: *Joseph and Mary attend event Jerusalem. Mary birth Jesus.*

As you can see above, the words in bold have been extracted and joined to create a summary — although sometimes the summary can be grammatically strange.

- **Abstraction-based summarization**

The abstraction technique entails paraphrasing and shortening parts of the source document. When abstraction is applied for text summarization in deep learning problems, it can overcome the grammar inconsistencies of the extractive method.

The abstractive text summarization algorithms create new phrases and sentences that relay the most useful information from the original text — just like humans do.

Therefore, abstraction performs better than extraction. However, the text summarization algorithms required to do abstraction are more difficult to develop; that's why the use of extraction is still popular.

Here is an example:

Abstractive summary: *Joseph and Mary came to Jerusalem where Jesus was born.*

How does a text summarization algorithm work?

Usually, text summarization in NLP is treated as a supervised machine learning problem (where future outcomes are predicted based on provided data).

Typically, here is how using the extraction-based approach to summarize texts can work:

1. Introduce a method to extract the merited keyphrases from the source document. For example, you can use part-of-speech tagging, words sequences, or other linguistic patterns to identify the keyphrases.
2. Gather text documents with positively-labeled keyphrases. The keyphrases should be compatible to the stipulated extraction technique. To increase accuracy, you can also create negatively-labeled keyphrases.
3. Train a binary machine learning classifier to make the text summarization. Some of the features you can use include:

- Length of the keyphrase
- Frequency of the keyphrase
- The most recurring word in the keyphrase
- Number of characters in the keyphrase

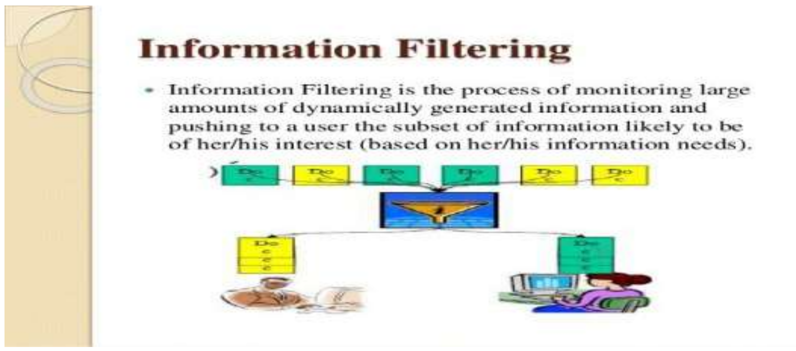
4. Finally, in the test phrase, create all the keyphrase words and sentences and carry out classification for them.

Information Filtering

information filtering deals with the delivery of information that the user is likely to find interesting or useful. An information filtering system assists users by filtering the data source and deliver relevant information to the users. When the delivered information comes in the form of suggestions an information filtering system is called a recommender system. Because users have different interests the information filtering system must be personalized to accommodate the individual user's interests. This requires the gathering of feedback from the user in order to make a user profile of his preferences.

Two major approaches exist for information filtering: Content-based filtering and collaborative filtering.

A content-based filtering system selects items based on the correlation between the content of the items and the user's preferences, while a collaborative filtering system chooses items based on the correlation between people with similar preferences.



Content-based filtering, also referred to as cognitive filtering, recommends items based on a comparison between the content of the items and a user profile. The content of each item is represented as a set of descriptors or terms, typically the words that occur in a document. The user profile is represented with the same terms and built up by analyzing the content of items which have been seen by the user.

Content-based filtering methods are based on a description of the item and a profile of the user's preferences.[40][41] These methods are best suited to situations where there is known data on an item (name, location, description, etc.), but not on the user. Content-based recommenders treat recommendation as a user-specific classification problem and learn a classifier for the user's likes and dislikes based on product features.

In this system, keywords are used to describe the items and a user profile is built to indicate the type of item this user likes. In other words, these algorithms try to recommend items that are similar to those that a user liked in the past, or is examining in the present.

cosine similarity.

This is one of the metric that we can use when calculating similarity, between users or contents. The definition of similarity between two vectors **u** and **v** is, in fact, the ratio between their dot product and the product of their magnitudes.

$$similarity = cos(\theta) = \frac{\boldsymbol{u} \cdot \boldsymbol{v}}{\|\boldsymbol{u}\| \|\boldsymbol{v}\|} = \frac{\sum_{i=1}^{n} u_i v_i}{\sqrt{\sum_{i=1}^{n} u_i^2} \sqrt{\sum_{i=1}^{n} v_i^2}}$$

By applying the definition of similarity, this will be in fact equal to 1 if the two vectors are identical, and it will be 0 if the two are orthogonal. In other words, the similarity is a number bounded between 0 and 1 that tells us how much the two vectors are similar.

Collaborative filtering, also referred to as social filtering, filters information by using the recommendations of other people. It is based on the idea that people who agreed in their evaluation of certain items in the past are likely to agree again in the future. A person who wants to see a movie for example, might ask for recommendations from friends. The recommendations of some friends who have similar interests are trusted more than recommendations from others. This information is used in the decision on which movie to see.

Most collaborative filtering systems apply the so called neighborhood-based technique. In the neighborhood-based approach a number of users is selected based on their similarity to the active user. A prediction for the active user is made by calculating a weighted average of the ratings of the selected users.

To illustrate how a collaborative filtering system makes recommendations consider the example in movie ratings table below. This shows the ratings of five movies by five people. A “+” indicates that the person liked the movie and a “-“ indicates that the person did not like the movie. To predict if Ken would like the movie “Fargo”, Ken’s ratings are compared to the ratings of the others. In this case the ratings of Ken and Mike are identical and because Mike liked Fargo, one might predict that Ken likes the movie as well.

Movie ratings

	Amy	**Jef**	**Mike**	**Chris**	**Ken**
The Piano	–	–	+		+
Pulp Fiction	–	+	+	–	+
Clueless	+		–	+	–
Cliffhanger	–	–	+	–	+
Fargo	–	+	+	–	**?**

Instead of just relying on the most similar person, a prediction is normally based on the weighted average of the recommendations of several people. The weight given to a person’s ratings is determined by the correlation between that person and the person for whom to make a prediction. As a measure of correlation the Pearson correlation coefficient can be used. In this example a positive rating has the value 1 while a negative rating has the value –1, but in other cases a rating could also be a continuous number. The ratings of person *X* and *Y* of the item *k* are written as X_k and Y_k, while $\bar{X}$ and $\bar{Y}$ are the mean values of their ratings. The correlation between *X* and *Y* is then given by:

$$r(X,Y)=\frac{\sum_k (X_k-\bar{X})(Y_k-\bar{Y})}{\sqrt{\sum_k (X_k-\bar{X})^2 \sum_k (Y_k-\bar{Y})^2}}$$

In this formula *k* is an element of all the items that both *X* and *Y* have rated. A prediction for the rating of person *X* of the item *i* based on the ratings of people who have rated item *i* is computed as follows:

$$p(X_i)=\frac{\sum_Y Y_i \cdot r(X,Y)}{n}$$

Where *Y* consists of all the *n* people who have rated item *i*. Note that a negative correlation can also be used as a weight. For example, because Amy and Jef have a negative correlation and Amy did not like “Farg” could be used as an indication that Jef will enjoy “Fargo”.

The Pearson correlation coefficient is used by several collaborative filtering systems including GroupLens [Resnick et al. 1994] and Ringo [Shardanand 1994, Shardanand & Maes 1995]. GroupLens, a system that filters articles on Usenet, was the first to incorporate a neighborhood-based algorithm. In GroupLens a prediction is made by computing the weighted average of deviations from the neighbor’s mean:

$$p(X_i) = \overline{X} + \frac{\sum_{Y} (X_i - \overline{X}) \cdot r(X,Y)}{\sum_{Y} r(X,Y)}$$

Note that if no one has rated item *i* the prediction is equal to the average of all the ratings person *X* has made. Ringo recommends music albums and artists a person might be interested in. Shardanand considers several collaborative algorithms and reports that a constrained Pearson *r* algorithm performs best for Ringo's information domain. The constrained Pearson measure is similar to the normal Pearson measure but uses the mean value of possible rating values (in this case the average is 4) instead of the mean values of the ratings of person *X* and *Y*.

Hybrid systems that follow this approach are based on the idea that incorporating both content and social information could lead to a better filtering technique

In collaboration via content both the rated items and the content of the items are used to construct a user profile. The selection of terms which describe the content of the items is done using content-based techniques. The weight of terms indicate how important they are to the user. In the table below an example is shown of what kind of information is available to make a prediction about the movie "Fargo" for Ken with collaboration via content. Five terms are shown which describe the sort of movie a user is interested in.

Five terms and movie ratings

	comedy	**historical**	**high-school**	**violence**	**black-humor**	**Fargo**
Amy	1	0	1.2	0.2	0.2	–
Jef	2.1	0	0.5	3	2.2	+
Mike	1.3	1.5	0.2	3.2	1.9	+
Chris	1.1	2	2.8	0.8	0	–
Ken	0.8	1.1	0	2	1.2	**?**

Just as with collaborative filtering, the Pearson correlation coefficient can be used to compute the correlation between users. Instead of determining the correlation with user ratings however, term weights are used. Because this method has a greater number of items from which to determine similarity than collaborative filtering the problem of users not having enough rated items in common is not an issue anymore. Furthermore, unlike content-based filtering, predictions are based on the impressions of other users which could lead to recommendations outside the normal environment of a user. However to make recommendations about items it is still necessary that there are enough users who have rated the item. Just as with collaborative filtering new items can not be recommended as long as there aren't any user who have rated the new item.

Uncertainity

Uncertainity in information theory

Information theory, formulated by Claude Shannon, says that information reduces uncertainty.In his information theory, Claude Shannon defined "entropy" as a measure of uncertainty with respect to some variable or event. The greater the uncertainty, the greater the "Shannon entropy."

Shannon proposed that information reduces uncertainty and therefore reduces entropy. A typical example of this principle is flipping a two-sided coin. When tossing a coin, we are uncertain about the two possible outcomes. By observing the outcome (say, heads), we gain information that reduces the uncertainty about this event.

Sources of Uncertainty in Information Systems

Information System. An information system is a computer model of some portion o Elements affected by uncertainty. Depending on the model used, descriptions may take different forms, and uncertainty could affect each of them.

- Consider, for example, relational databases. The structures of the relational model admit different kinds of uncertainty. The first kind involves uncertainty at the level of data values; for example, the values of salary in the relation earn (employee, salary) might be uncertain. The second kind involves uncertainty at the level of the tuple; for example, the values of each of the attributes of the relation assign (employee, project) may be certain, but there might be uncertainty about the precise assignment of employees to projects. A third kind involves uncertainty at the level of the relation (the structure); for example, there might be uncertainty whether employees may belong to more than one department, and hence what should be the proper description of this relationship [4].
- As another example, consider an information retrieval system that models each document with an identifier and a vector of keywords. There might be uncertainty at the level of a keyword; i.e., the appropriateness of a specific keyword to a given document may be questionable. In addition, there might be uncertainty at the level of an entire document; i.e., the existence of some documents may be in doubt.
- As a third example, consider an expert system that models real world knowledge with facts and rules expressed in logic. There might be uncertainty about specific facts (similar to the tuple uncertainty in relational databases), and there might be uncertainty about specific rules; i.e., a rule might be only an approximation of the behavior of the real world of the real world.

  Sources of Uncertainty

  - Uncertainty might result from using unreliable information sources, such as faulty reading instruments, or input forms that have been filled-out incorrectly (intentionally or inadvertently).
  - In other cases, uncertainty is a result of system errors, including input errors, 4 transmission "noise", delays in processing update transactions, imperfections of the system software, and corrupted data owing to failure or sabotage.
  - At times, uncertainty is the unavoidable result of information gathering methods that require estimation or judgement.

Degrees of uncertainty

- Uncertainty is highest when the mere existence of some real world object is in doubt. The simplest solution is to ignore such objects altogether. This solution, however, is unacceptable if the model claims to be closed world (i.e., objects not modeled do not exist).
- Uncertainty is reduced somewhat when each element is assigned a value in a prescribed range, to indicate the certainty that the modeled object exists. When the element is a fact, this value can be interpreted as the confidence that the fact holds; when it is a rule, this

value can be interpreted as the strength of the rule (percent of cases where the rule applies).

- Uncertainty is reduced when the information that describes an object is known to come from a limited set of alternatives (possibly a range of values). This uncertainty is referred to as disjunctive information
- Uncertainty is reduced even further when each alternative is accompanied by a number describing the probability that it is indeed the true description (and the sum of these numbers for the entire set is 1). In this case, the uncertain information is probabilistic.

Inferences

Inferences are steps in reasoning, moving from premises to logical consequences; . the word *infer* means to "carry forward". Inference is theoretically traditionally divided into deduction and induction

Inductive reasoning is a method of reasoning in which the premises are viewed as supplying *some* evidence for the truth of the conclusion;

The following are types of inductive argument. Notice that while similar, each has a different form.

Generalization

A generalization (more accurately, an *inductive generalization*) proceeds from a premise about a sample to a conclusion about the population.

The proportion Q of the sample has attribute A.
Therefore:
The proportion Q of the population has attribute A.

Example

There are 20 balls—either black or white—in an urn. To estimate their respective numbers, you draw a sample of four balls and find that three are black and one is white. A good inductive generalization would be that there are 15 black and five white balls in the urn.

How much the premises support the conclusion depends upon (a) the number in the sample group, (b) the number in the population, and (c) the degree to which the sample represents the population (which may be achieved by taking a random sample).

Statistical syllogism

A statistical syllogism proceeds from a generalization to a conclusion about an individual.

90% of graduates from Excelsior Preparatory school go on to University.
Bob is a graduate of Excelsior Preparatory school.
Bob will go on to University.

This is a *statistical syllogism*

Simple induction

Simple induction proceeds from a premise about a sample group to a conclusion about another individual.

Proportion Q of the known instances of population P has attribute A.
Individual I is another member of P.
Therefore:
There is a probability corresponding to Q that I has A.

This is a combination of a generalization and a statistical syllogism, where the conclusion of the generalization is also the first premise of the statistical syllogism.

enumerative induction

All life forms so far discovered are composed of cells.

All life forms are composed of cells.

This is *enumerative induction*, aka *simple induction* or *simple predictive induction*. It is a subcategory of inductive generalization. In everyday practice, this is perhaps the most common form of induction.

Argument from analogy

The process of analogical inference involves noting the shared properties of two or more things and from this basis inferring that they also share some further property:[9]

P and Q are similar in respect to properties a, b, and c.

Object P has been observed to have further property x.

Therefore, Q probably has property x also.

Analogical reasoning is very frequent in common sense, science, philosophy and the humanities

Prediction

A prediction draws a conclusion about a future individual from a past sample.

Proportion Q of observed members of group G have had attribute A.

Therefore:

There is a probability corresponding to Q that other members of group G will have attribute A when next observed.

Deductive reasoning, also **deductive logic**, is the process of reasoning from one or more statements (premises) to reach a logically certain conclusion

An example of an argument using deductive reasoning:

1. All men are mortal. (First premise)
2. Socrates is a man. (Second premise)
3. Therefore, Socrates is mortal. (Conclusion)

The first premise states that all objects classified as "men" have the attribute "mortal." The second premise states that "Socrates" is classified as a "man" – a member of the set "men." The conclusion then states that "Socrates" must be "mortal" because he inherits this attribute from his classification as a "man."

Reasoning with modus ponens, modus tollens, and the law of syllogism

Modus ponens (also known as "affirming the antecedent" or "the law of detachment") is the primary deductive rule of inference. It applies to arguments that have as first premise a conditional statement ($P \rightarrow Q$) and as second premise the antecedent (P) of the conditional statement. It obtains the consequent (Q) of the conditional statement as its conclusion. The argument form is listed below:

1. $P \rightarrow Q$ (First premise is a conditional statement)
2. P (Second premise is the antecedent)
3. Q (Conclusion deduced is the consequent)

The following is an example of an argument using modus ponens:

1. If an angle satisfies 90° < A < 180°, then A is an obtuse angle.
2. A = 120°.
3. A is an obtuse angle.

Since the measurement of angle A is greater than 90° and less than 180°, we can deduce from the conditional (if-then) statement that A is an obtuse angle. However, if we are given that A is an obtuse angle, we cannot deduce from the conditional statement that 90° < A < 180°. It might be true that other angles outside this range are also obtuse.

Modus tollens (also known as "the law of contrapositive") is a deductive rule of inference. It validates an argument that has as premises a conditional statement ($P \to Q$) and the negation of the consequent ($\neg Q$) and as conclusion the negation of the antecedent ($\neg P$). In contrast to modus ponens, reasoning with modus tollens goes in the opposite direction to that of the conditional. The general expression for modus tollens is the following:

1. $P \to Q$. (First premise is a conditional statement)
2. $\neg Q$. (Second premise is the negation of the consequent)
3. $\neg P$. (Conclusion deduced is the negation of the antecedent)

The following is an example of an argument using modus tollens:

1. If it is raining, then there are clouds in the sky.
2. There are no clouds in the sky.
3. Thus, it is not raining.

Law of syllogism

In proposition logic the *law of syllogism* takes two conditional statements and forms a conclusion by combining the hypothesis of one statement with the conclusion of another. Here is the general form:

1. $P \to Q$
2. $Q \to R$
3. Therefore, $P \to R$.

The following is an example:

1. If the animal is a Yorkie, then it's a dog.
2. If the animal is a dog, then it's a mammal.
3. Therefore, if the animal is a Yorkie, then it's a mammal.

UNIT–IV

Decision – Support Systems: Decision – Making: A Concept, Simon's Model of Decision – Making Types of Decisions, Methods for Choosing Among Alternatives, Decision – Making and MIS, Decision Support Systems – Why?, Decision Support Systems: A framework, Characteristics and Capabilities of DSS

Business Intelligence and knowledge Management System: Business Intelligence, Knowledge Management System

DECISION SUPPORT SYSTEMS

Decision –making: A concept:

- Decision making has been taken from the word 'decide' which is a latin word meaning cut off or to come to a conclusion.
- Decision represents a behavior selected from a number of possible alternatives.
- A decision making is a process of selecting one optimum alternative from among alternatives of course of action.
- A decision is a end or the final product of the decision making process.
- Decisions are not static and have to be responsive to varying situations.
- Decision making means choosing one cause of action rather than another and finding appropriate solution to a new problem posed by a dynamic world.
- However there is no option i.e. only one alternative is available there is no decision to be made.

Simons model of decision- making:

In organizations decision-making is regarded as a rational process.
Simon has given a model to describe the decision making process. The model comprises of 3 major phases

i. Intelligence
ii. Design and
iii. Choice

Intelligence phase:

The decision maker scans the environment and identifies the problem .the scanning of environment may be continuous or intermittent.
A production manager reviews the daily scrap report to check for problems relating to quality control.
A sales executive periodically visits key customers to review possible problems and to identify New customer needs
Intelligence phase of the decision making process involves:

a. problem searching
b. problem formulation

problem searching:

problem is defined as he difference between something that is expected and reality.
Desired/Expected –Actual/Reality=Differnce(problem)

The reality or actual is compared to some standard. various types models can be used to compare reality.
Some of them are:

i. Planning model
ii. Historical models based on extrapolation
iii. Models used by other people in organization
iv. Extra organizational models in which expectations are derived from competition, customers and consultants etc.

Problem formulation:

- When the problem is identified there is always a risk of solving wrong problem. To avoid risk it is very important that the problem is well-understood and clearly stated.
- We have to simplify the problem the by determining its boundaries, breaking it down into smaller manageable sub problems on focusing the controllable elements. In problem formulation, establishing relations With some problem solved earlier or an analogy proves quite useful.

Design Phase:

- In this phase, the decision-maker identifies alternative courses of action to solve the problem.
- Developing of various alternatives is a time-consuming and crucial activity as the decision-maker has to explore all possible alternatives and he cannot take a risk of missing any alternative, as the missed-out alternative might be the best one.
- Developing alternatives is a creative -activity which can be enhanced by various aids such as brain-storming, checklists, analogies, etc.

Choice Phase

- At this stage, one of the alternatives developed in design phase is selected and is called a decision. For selecting an alternative, a detailed analysis of each and every alternative is made. Having made the decision, it is implemented.
- Simon's model of decision-making suggests three phases and the flow of activities is from intelligence to design to choice.
- at any phase, the decision-maker may return to a previous phase.

TYPES OF DECISIONS:

- Organizational decisions differ in a number of ways. These differences affect the development of alternatives and the choice among them. They also affect the design of information system support for decision activities.
- The following bases are important to classify decisions.

Purpose of Decision-making:

Robert B. Anthony (1965) has differentiated organizational decisions into three categories, namely, strategic planning decisions. Management control decisions and operational control decisions.

Strategic planning: decisions are those decisions in which the decision-maker develops objectives and allocates resources to achieve these objectives.
Decisions in this category are of long-time period and usually involve a large investment and effort. Such decisions are taken by strategic planning level (top level) managers.

Examples of such decisions may include introduction of new product, acquisition of another firm, etc.

Management control decisions: are taken by management control level (middle level) manage and deal with the use of resources in the organization.

Analysis of variance, product mix planning decisions fall in this category of decisions.

Operational control decisions: deal with the day-to-day problems that affect the operation the organisation. For example, production scheduling decisions and inventory control decisions like the product to be produced for the day or the items and their quantities to be ordered operational control decisions Such type of decisions are normally taken by managers at operational level (bottom level) of the management hierarchy in the organisation.

Level of Programmability: Simon (1965) on the basis of the level of the programmability of a decision, proposed two types decisions; programmed and non-programmed, also known as structured and unstructured decisions.

Programmed/Structured Decisions:

- Programmed or structured decisions are those decisions, which are well defined and some specific procedure or some decision rule may be applied to reach a decision.
- Such decisions are routine and repetitive and require little time for developing alternatives in the design phase..
- More modern techniques for making such decisions involve operation research (OR), mathematical analysis, modelling and simulation, etc.

Non-progrommed/Unstructured Decisions :

- Decisions which are not well-defined and have no pre-specified procedure or decision rule are known as unstructured or non-programmed decisions. For these decisions, sufficient time has to be spent in the design phase.
- Unstructured decisions tend to be solved through judgement, intuition and the rule of thumb. Modern approaches to such decisions include special data analysis on computer, heuristic techniques, etc.
- Decisions of this kind are usually handled by strategic planning level managers. Many decision situations in the real world are either unstructured or structured ones. decision situations, which do not fall within any of these two extremes, are known as semi-structure' decisions

Table 9.1
Different Classes of Decisions

Class	Operational Control	Management Control	Strategic Planning
Structured	Order processing Accounts receivable	Budget analysis	Warehouse location
Semi-structured	Inventory control Production scheduling	Analysis of variance	Introduction of new product
Unstructured	Cash management	Budget formulation, Long-term forecast	R&D Planning

Knowledge of Outcomes:

Another approach of classifying decisions is the level of knowledge of outcomes.

An outcome defines what will happen, if a decision is made or course of action taken. When there are more than one alternatives, the knowledge of outcome becomes important. On the basis of the level of knowledge of outcomes, decision-making can be classified into three categories of

(i) Decision under certainty,
(ii) Decision under risk, and
(iii) Decision under uncertainty.

Decision Under Certainty :

- Decision-making under certainty takes place when the outcome of each alternative is fully known. There is only one outcome for each alternative.
- In such a situation, the decision-maker is required to compute the optimal alternative or outcome. Various optimization techniques may be used for such decisions.

Decision Under Risk:

Decision-making under risk occurs when there is a possibility of multiple outcomes of each alternative and a probability of occurrence can be attached to each outcome. Such a decision-making is also similar to decision-making under certainty, where instead of optimising outcomes, the general rule is to optimize the expected outcome.

Outcome x Probability = Expected Value
S1 1,00,000 x 0.02 = 2,000
S2 10,000 x 0.80 = 8,000

Decision Under Uncertainty:

- Decision-making under uncertainty takes place when there are a number of outcomes for each alternative and the probabilities of their occurrence are not known.
- Optimization criteria cannot be applied for making decisions under uncertainty because there is no knowledge of the probabilities. Under such a situation different people take decisions applying different decision rules.
- Some may assign equal probabilities to all the outcomes for each alternative, so as to treat the decision making as a decision-making under risk. Whereas others may adopt different criteria, such as minimise regret, Maximax and Maximin criteria.

METHODS FOR CHOOSING AMONG ALTERNATIVES

A decision-maker makes use of various methods for choosing among alternatives. These methods generally assume that all alternatives are known.

1. **Decision Theory or Decision Analysis:**
    - The decision theory (decision analysis) refers to the techniques for analyzing decisions under risk and uncertainty.
    - In the process of decision-making, the decision-maker wants to achieve something which may be called his goal, purpose or objective.
    - The decision-maker may choose one particular alternative, which is called Strategy of the decision-maker, from among various alternatives.

- All alternatives and outcomes are assumed to be known. There are certain factors which affect the, outcome for different strategies.
- But these factors or conditions, also called 'states of nature', are beyond the control of the decision-maker.
- The strategy (alternative) along with the state of nature determines the degree to which the goal is actually achieved. A measure of achievement of the goal is called the `Pay-off'.
- The pay-off matrix is used as a method of presenting data in decision-analysis. A pay-of matrix is a good representation of the decision-problem because the alternatives or strategies available to the decision-maker may be represented by rows and conditions (states of nature) by columns. Each cell, which is an intersection of a strategy and a state of nature, contains the pay off. If the state of nature is known with certainty, the decision-maker is required only to select the strategy that provides him the highest pay-off. Let us explain the concept of the payoff matrix by taking an example.

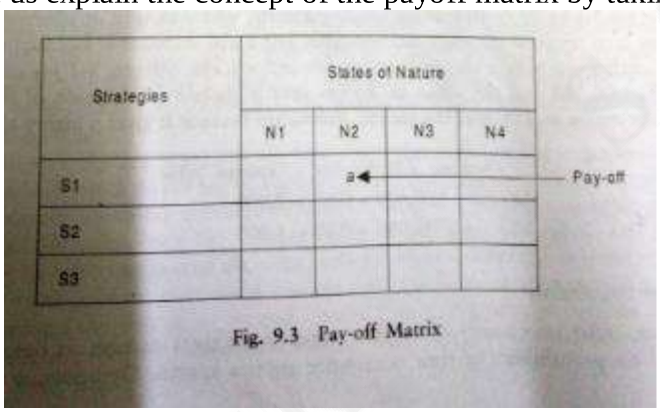


Fig. 9.3 Pay-off Matrix

Assume that a marketing manager of a computer manufacturer is to choose from three alter-natives.

1. Modify the existing PC to improve its design and processing power.
2. Launch a new PC having latest technology.
3. Do nothing, i.e. leave the PC as it is.

There are three states of nature that affect the pay-off from each of the alternative strategies. These states of nature are:

(i) A competitor may launch a new PC with latest technology.
(ii) The government may impose high excise duty on the manufacture of PCs and reduce excise to minimum on laptops to encourage the use of laptops.
(iii) Conditions will remain the same as they are.

The various pay-offs (profit or loss) from the combination of a strategy and a state of nature are given in the pay-off matrix

(Pay-offs in lakh of rupees)

Strategies	States of Nature		
	Same Conditions 0.40	New Competitor 0.40	Govt. Ban 0.20
(S1) Modify	7	5	−5
(S2) New Product	10	3	−13
(S3) Do Nothing	5	1	−2

Fig. 9.4 Pay-off Matrix

It can seen that there are three states of nature whose probabilities of occurrence is known. This problem situation is called decision under risk.

The expected value is determined by multiplying each payoff by the probability of occurrence of the state of nature (given in columns) and summing these values across all states of nature (across the rows).

In the above example, the expected vale (EV) of each strategy is:

EV of S1 = (7)(0.40) + (5)(0.40 + —5)(0.20)

2.8 + 2.0 — 1.0 a= 3.8

EV of S2 = (10)(0.40) + (3)(0.40) + (-13)(0.20)

4.0 + 1.2 — 2.6 = 2.6

EV of S3 = (5)(0.40) + (1)(0.40) +(-2)(0.20)

2.0 ÷ 0.4 — 0.4 =2.0

The maximum expected value 3.8 lakh is found to be of the option to modify and if the Decision is made based on the expected value objective function, the strategy S1, i.e. to modify the e PC will he selected.

As already mentioned, in decision-making under risk, the probabilities of various states nature are assumed to be known. However, in the case of decision-making under uncertain probabilities of the various states of nature are not known to the decision-maker and thus cannot apply the maximisation/minimisation of expected value criteria as in the case of de under risk.

In such a decision problem, the following decision rules/criteria, depending upon attitude of the decision-maker, may be applied.

(i) Maximax rule or criterion of optimism,
(ii) Maximin rule or criterion of pessimism,
(iii) Criterion of minimise regret, and
(iv) Criterion of rationality.

In order to understand the above criteria, let us take the earlier example, assuming no knowledge of probability.

Strategies	States of Nature		
	Same Conditions	New Competitor	Govt. Ban
(S1) Modify	7	5	−5
(S2) New Product	10	3	−13
(S3) Do Nothing	5	1	−2

Fig. 9.5 Pay-off Matrix (where probabilities of states of nature are not known)

(i) **Maximax or Criterion of Optimism**

- In this case, the decision-maker is of optimistic attitude and thus would select the strategy which will provide him the greatest (max) pay-off under the most favourable or the best condition (max).
- In the above example, the decision-maker will select strategy S2 which will give him a maximum pay-offs 10 lakh for launching a new PC and for the same conditions

Table 9.2

Strategy	Maximum or the Best Pay-off	
S1	7	
S2	10	← Maximax
S3	5	

(ii)**Maximin or Criterion of Pessimism**

- the decision-maker is of pessimistic attitude and select the strategy which will give him the highest pay-off (max) if the worst condition (min) occurs.
- there the decision maker being pessimistic view will not like to take any risk and this will think about the safest position in the worst situation.
- The maker will select s3 since in worst situation

Table 9.3

Strategy	Worst or minimum Pay-off	
S1	− 5	
S2	− 13	← Minimum pay-off
S3	− 2	

(ii) Criterion of Regret

A decision-maker selects the strategy which minimizes the maximum regret for each decision.

The decision-maker would select each strategy which will give him the minimum of such maximum regrets.

Strategies	States of Nature		
	Same Conditions	New Competitor	Govt. Ban
(S1) Modify	10 − 7 = 3	5 − 5 = 0	−2 − (−5) = 3
(S2) New product	10 − 10 = 0	5 − 3 = 2	− 2 − (−13) = 11
(S3) Do nothing	10 − 5 = 5	5 − 1 = 4	− 2 − (−2) = 0

Table 9.4

Strategy	Maximum Regret	
S1	3	← Minimum of maximum regrets
S2	11	
S3	5	

(iii) **Criterion of Rationality**

- Criterion of rationality is also known Laplace Criterion, which assumes equal probabilities of various states of nature.
- The strategy which has the greatest expected pay-off is selected.
- In our example, the expected pay-off for each strategy is given in Table 9.5. As there art .states of nature, the probability of each state is assumed to be equal to 1/3.

Table 9.5

Strategy	Expected Pay-off	
S1	(1/3)(7 + 5 – 5) = 2.3	← Highest EV
S2	(1/3)(10 + 3 – 13 = 0	
S3	(1/3)(5 + 1 – 2) = 1.3	

In the above example, the following strategies may be selected.

Strategy	Criterion
S1	Regret criterion and Laplace criterion
S2	Maximax
S3	Maximin

Utility:

- It has been observed that in decision analysis, the various pay-offs are measured in monetary value (Rupees), but some of the factors like goodwill, image of an organisation, perception quality, advertising effects, etc. (qualitative in nature), are required to be considered.
- These need not be measured in monetary value.
- another measure, called Utility, having as its units is used.
- Utility function for money is diagrammatically shown in Fig.. The utility concept finds various applications in organizational decision-making as it helps to decide about the non-monetary d factors.

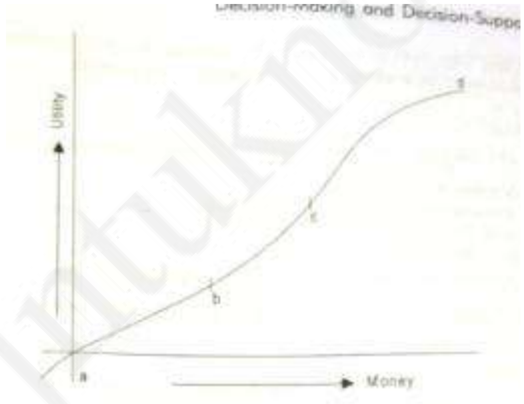


Fig. 9.6 Utility Functions

Decision Tree: is a graphic representation of a sequence of decisions and actions. It resembles like a tree. The root of the tree is the starting point of the decision sequence.
The particular branch to be followed depends on the conditions that exist, and the decision to be made

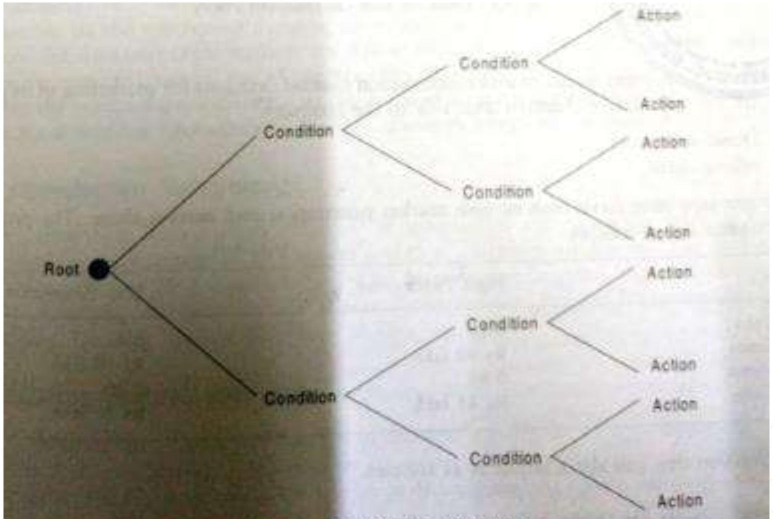


Fig. 9.7 Decision Tree Sequence

The decision tree helps both in structuring the problem, that is to understand the process logic of a problem as well as in its analysis.

Optimization techniques:

- These techniques assume that all alternatives and their outcomes are known.
- The decision maker is required to calculate the optimal alternative for objective function. Various techniques used are linear programming, integer programming ,dynamic programming etc.

DECISION MAKING AND MIS

Information Support for Decision-Making process:

Simon's model of decision-making proposes three stages in the decision-making process.
MIS plays its role in all the three stages.

Intelligence Stage

- In this stage, an information system may provide information about internal as well as external environments.
- Internal information is generated from the functional areas, whereas external information is collected from various sources, such as databases, newspapers, government reports, personal contacts, etc.
- In order to get the required information in the intelligence phase of decision-making, MIS must be designed so as to answer pre-specified as well as ad hoc queries (unique, unscheduled, situation-specific) made by the decision-maker. In other words, information system design may have various models (like historical planning and extra organisational) and a query language capability (decision support system capability).

Design Stage:

- At this stage, various alternatives are developed and evaluated. In the case of structured decisions, information systems can support by quantifying and automating a decision-making process.

- On the other hand, for semi-structured to unstructured decisions, information systems can support such decision-making by providing
  (i) the ability to make ad hoc queries for information in the organizational databases,
  (ii) the ability to reach a decision in an interactive process
- Thus, information systems should be designed to incorporate various models of business operations and advanced statistical, optimization techniques, etc., so that these could be used to manipulate information already collected in the intelligence stage to develop and evaluate various alternatives.

Choice Stage :

- It is the choice stage in which a course of action is selected and feedback is collected on the implemented decision.
- Information systems can provide summarized and organized information to the decision-makers at this stage.
- Several models may be used to select the most appropriate alternative and thus help decision-makers select the best course of action.
- Information systems can also help the decision-maker monitor the successful implementation of a decision by providing feedback.
- An information system, to support the choice stage of the decision-maker' should have optimisation models and suggestion models.

Techniques Used in Decision-Making:

The techniques often used in decision making are

(i) **Simulation**: In this approach, a mathematical model of the situation is created .main decision variables are defined and the model is operated under different assumptions starting conditions to help explore alternative paths for the real situation.

(ii) **optimisation**: In optimization technique, a mathematical model of the situation developed. The model is designed so that optimisation techniques can be used for optimal values of decision variables.

(iii) **OLAP and Data Mining**: It uses statistical techniques to analyze business results and find hidden relationships.

(iv) **Expert Systems**: Here an expert's view of an area of knowledge in terms of facts and rules are summarised and then the facts and rules to a particular situation are applied to help someone else decide what to do.

(v) **Neural Networks**: It starts with a large set of coded examples that represents the range and frequency of possibilities in the situation being studied. Neural networks apply automated statistical 'learning' techniques to find the statistical parameters that best present correlations between groups of characteristics within the trading set.

(vi) **Fuzzy Logic**: In this approach, decision processes are controlled using logic systems that replace 'either — or' logic with logic based on relative degrees of inclusion in sets.

(vii) **Case-based Reasoning**: This approach creates a database of examples that may help in making decision. Add another example to the database when the database does not cover a new situation.

(viii) **Intelligent Agents**: In this technique, decision parameters are specified for a computerized `agent' that searches one or more databases to find a specific answer, such as the lowest price for a particular mobile set.

DECISION SUPPORT SYSTEMS — WHY?

The need for computerized decision support systems for the following reasons:

(i) **Fast Computation:** A decision-maker can perform a large number of computations very quickly and that too at a low cost with the help of computer support systems. Today, in majority of the decisions, time is the essence.

(ii) **Enhanced Productivity:** Support systems can enhance the productivity of support staff and also enable the group members to discuss the problems among themselves at a distance.

(iii) **Data Transmission:** Sometimes the data, which may be stored at different locations, may be required to be transmitted quickly from distant locations. Computer support systems can search, store, and transmit the required data quickly and economically.

(iv) **Better Decisions:** Computer support systems can help a decision-maker in arriving at a better decision. For example, more alternatives can be evaluated, risk analysis be performed quickly, and views of experts from different places can be collected quickly and at a lower cost.

(v) **Competitive Edge:** Decision support systems enable the users to get a competitive edge over their competitors as these systems enable organisations to change their operations frequently, re-engineer processes and structures, empower employees and innovate. Decision support technologies can create useful empowerment by allowing people to make good decisions, even if they lack some knowledge.

DECISION SUPPORT SYSTEMS: A FRAMEWORK

- Decision Support Systems like MIS, have also been defined differently by different people and thus there is no universally accepted definition of DSS.
- It was in the early 1970s, when Scott Morton Pot defined DSS as an interactive computer-based system, which helps decision-makers utilize data and models to solve unstructured problems,
- A decision Support System is a specialized kind of information system, which is an interactive
- system that supports in the decision-making process of a manager in an organization, especially in semi-structured and unstructured situations.
- The system utilizes information, models, and data manipulation tools to help make decisions in semi-structured to unstructured situations.

CHARACTERISTICS AND CAPABILITIES OF DSS

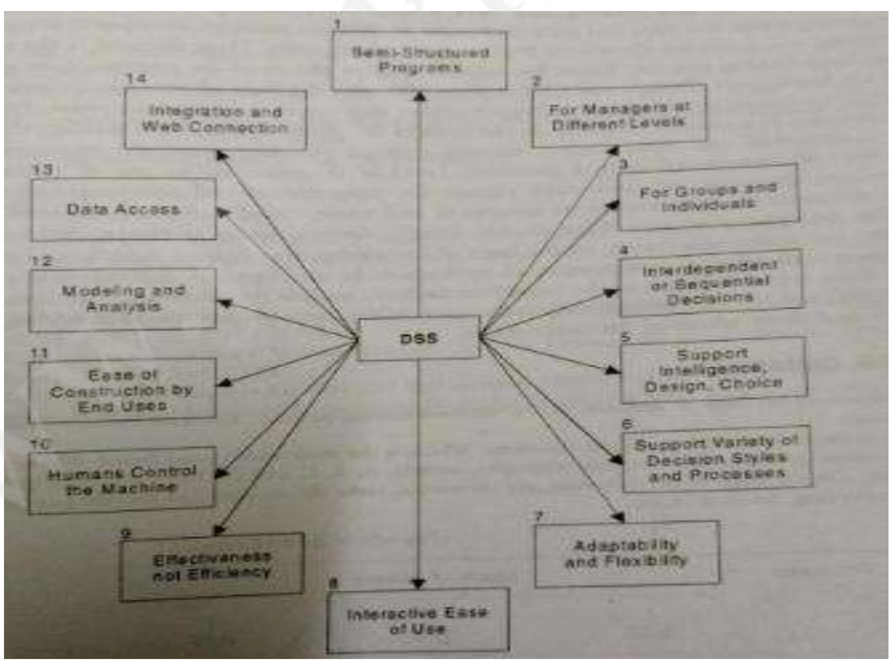
The major DSS characteristics and capabilities are

1. DSS provide support for decision-makers mainly in semi-structured and unstructured situation by bringing together human judgements and computerised information. Such problem cannot be solved or by other computerised systems

2. Support is provided for various managerial levels, ranging from top executives to line managers.
3. Support is provided to individuals as well as to groups. Less-structured problems often require the involvement of several individuals from different departments and organizational levels or even from different organisations.

4. DSS ' provide support to several interdependent and/or sequential decisions .the decisions may be made once, several times, or repeatedly. decisions.
5. DSS support all phases of the decision-making process: intelligence, design, choice, and implementation.
6. DSS support a variety of decision-making processes and styles.
7. DSS are adaptive over time. The decision-maker should be reactive, able to confront changing condition quickly, and be able to adapt the DSS to meet these changes.
8. Users must feel at home with DSS User-friendliness, strong graphical capabilities, and an English-like interactive human machine interface greatly increase the effectiveness.
9. The decision-maker has complete control over all steps of the decision-making process in solving a problem. A DSS specifically aims to support and not to replace the decision-maker.
10. End users should be able to construct and modify simple systems by themselves. Larger systems can be built with Assistance from information system (IS) specialists.
11. A DSS usually utilises models for analysing decision-making situations. The modeling capability enables experimenting with different strategies under different configurations.

A DSS can be employed as a stand alone tool used by individual decision-maker in one location, or it can be distributed throughout an organisation and in several organisations along the supply chain. It can be integrated with other DSS and/or applications and it can be distributed internally and externally, using networking and Web technologies.



BUSINESS INTELLIGENCE SYSTEM:

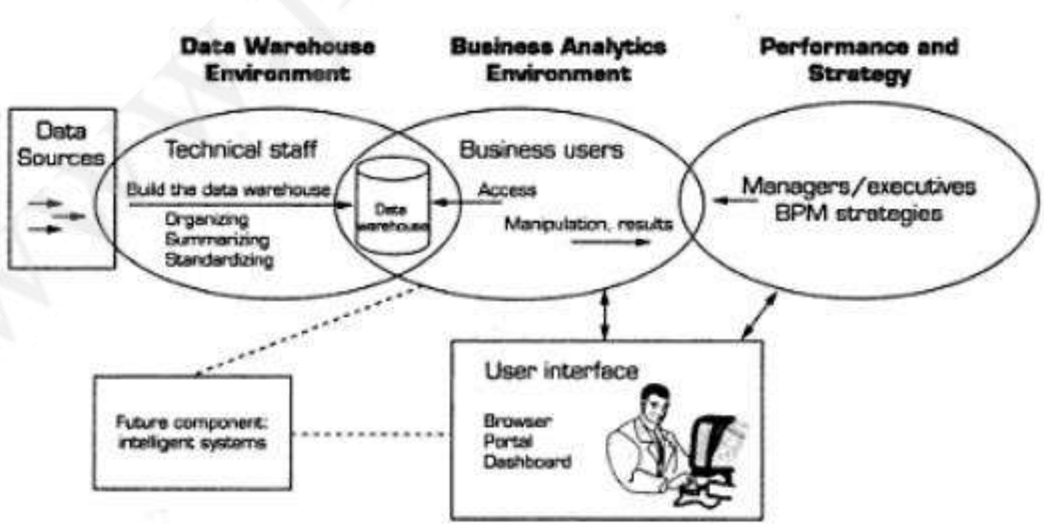
- Business intelligence(BI) is defined as knowledge about customers, the competitors , the business partners, the competitive environment and the internal operations of the organization.
- This knowledge enables the organization to make effective decisions that may have strategic implications for the business.
- Any business contained data as a by- product for the business transactions.
- Organizations collect and store this data electronically in databases and data warehouses.
- Organizations will process this data to know trends, patterns and unknown facts from this data to know about the customers and suppliers and can make better decisions.
- BI is to improve the timeliness and quality of the input for decision making

BI helps the managers to understand the following:

- Internal capabilities of the organization
- Trends and future directions in the markets
- External environment such as economic, political, social, technological and demographic environment
- Behavior of the competitors.

- BI is a way to truly understand the markets, competitors and processes.
- It used software technology such as data warehouses, data marts, and data mining or online analytical processing(OLAP) makes it possible to shift the data to find out trends and patterns that can be used to improve profitability.
- The organizations that develop BI tools to create interfaces that help the managers to quickly grasps the business situations

The Architecture of BI



Online analytical processing (OLAP)

- OLAP are multidimensional databases. These will allow analysts to display data in one or more number of different dimensions such as time, geographic region, product, organizational department, customer, or other factors.
- These are designed to easily analyze the data.
- It is an extension of the SQL frame work.
- An OLAP application focuses more on analyzing trends or other aspects of organizational operations.
- It may obtain information from the data warehouses.
- Data analytics software uses statistical tools to provide the organizations the friendly environment in data processing and timely decision making.
- Drilling down is a process in which one starts with a table that shows broad information and gradually retrieves tables of more specific information.

Data mining queries

- These are more sophisticated queries that the traditional queries.
- Data mining allows you to ask what patterns exist.
- The combination of data warehousing techniques and data mining software makes it easier to predict future outcomes based on patterns discovered with in historical data.

Data mining had 4 objectives:

- **Sequence or path analysis:** finding patterns where one event leads to another.
- **Classification**: finding whether certain facts fall into predefined groups
- **Clustering:** finding groups of related facts not previously known
- **Forecasting:** discovering patterns in data that can lead to reasonable predictions.

BI applications in business

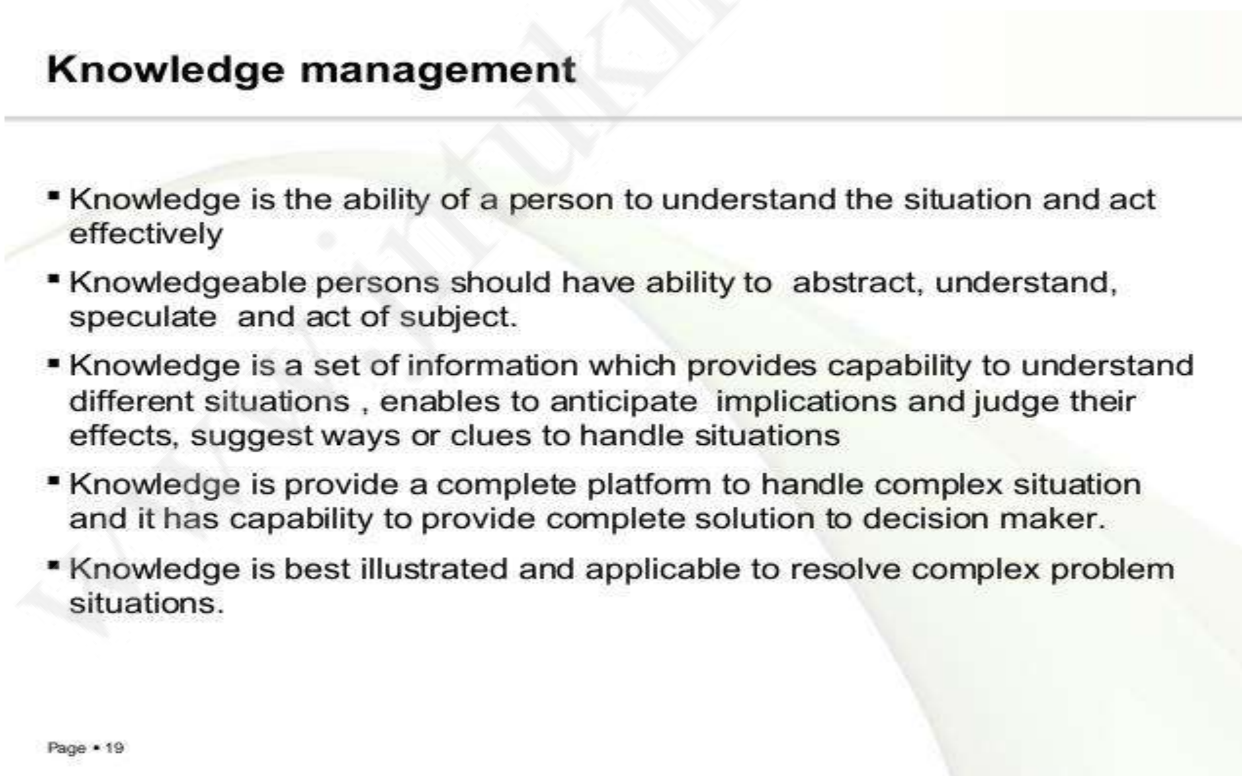
The applications are

- **Retailing:**
  Retailers can get valuable predictive information from data mining .data mining tools can be used to find the likings, disliking, shopping behavior and other patterns and becomes very effective in formulating and implementing retailing strategies.
- **Customer relationship management:**
  CRM allows business to identify the profitability of the specific customers and to increase the chances of retaining them. This can be done by having the relevant information that is needed to planning, development and selling of the products. it is important to motivate the customers to provide them the right product, at the right place and at the right price.
- **Credit card management:**

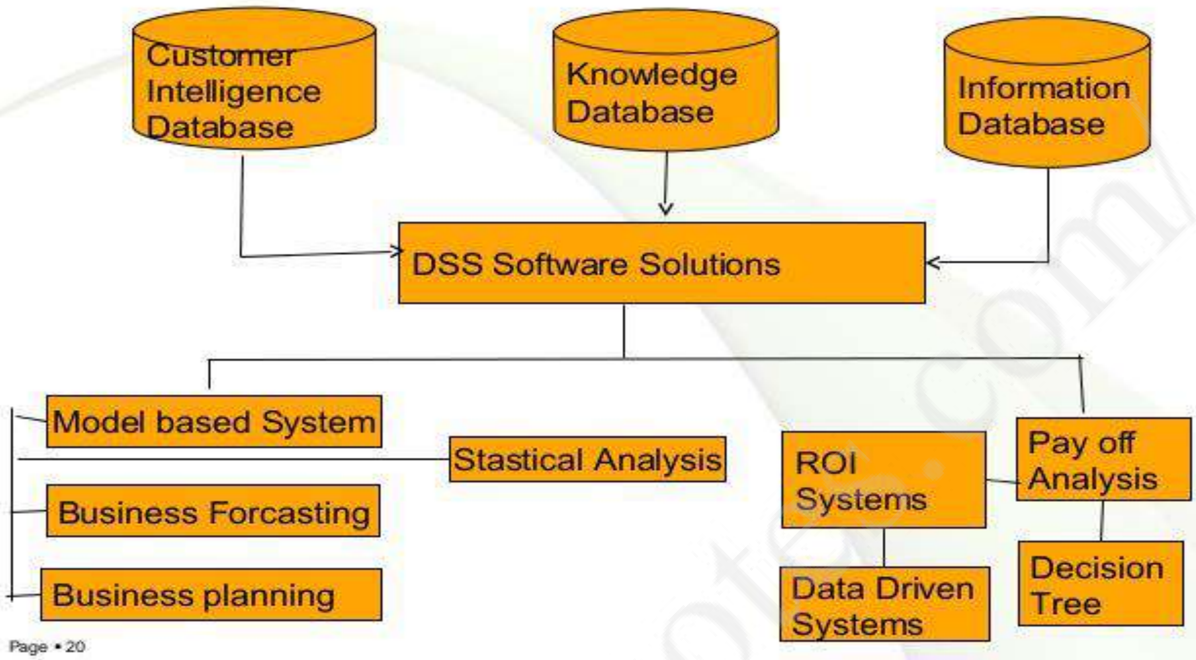
Data mining can be used in credit card management, it finds out the profitable customers and can target its campaign to the right set of the customers. Data warehoused provide the information to more accurately predict what the customer is interested in.

- **Insurance:**
  The insurance industry can be used to detect the frauds and to market its products using data mining tools.
- **Telecommunications:**
  It uses data mining tools to retain their customers in telecommunication. The phenomenon of a customer switching carriers is referred to as chum. data mining reduces their customer churn.
- **Telemarketing**:
  Telephone providers use many marketing operations utilizing telemarketing. Data mining is used to collect the data of their customers who respond to the new promotions, discounts, new product offers.
- **Human resource management:**
  BI analysis in the human resource area to identify the individuals who may leave the company if some benefits are offered to them. Data mining can be used to formulate the strategies to efficiently use its human resources. This analysis helps them to know that the talented people are working for their units or not.

<u>Knowledge management system (KMS</u>)



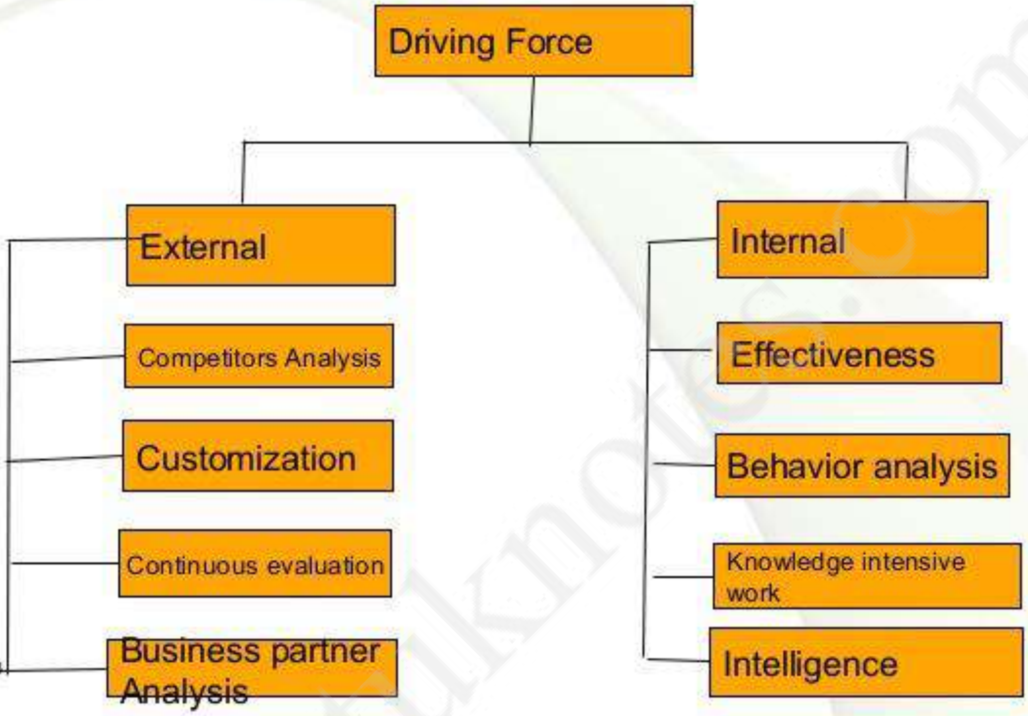
Structure and Architecture of Knowledge



Knowledge Management

- KM has following processes
- Define,capture,manipulate,store and develop
- Develop information systems for knowledge creation
- Design applications for improving organization's effectiveness
- Create knowledge set for example intellectual capital to increase economics.
- Keep IC continuously on upgrade to use it is a central resource
- Distribute and share to concerned

Knowledge Management- Driving forces

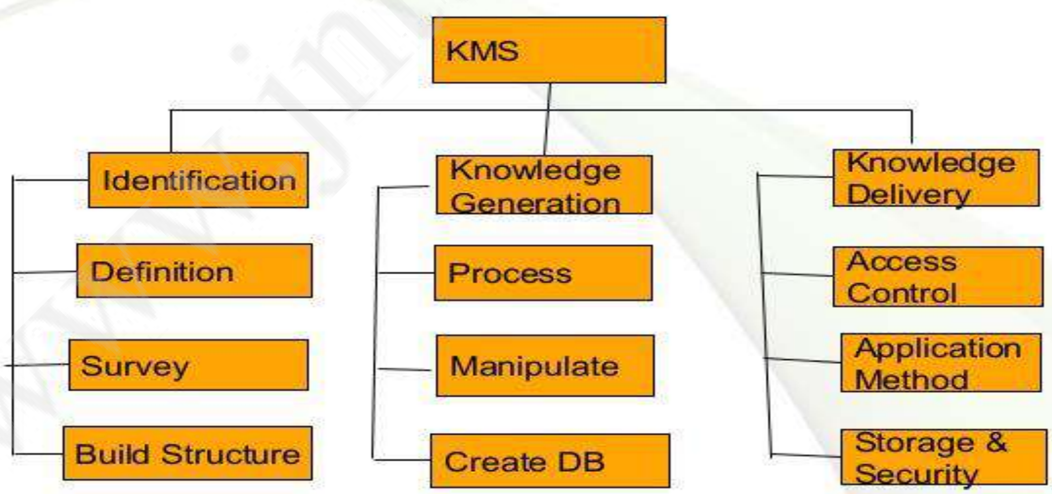


Knowledge Management Systems

- Some facts about knowledge management

Facts	Comments
Km leads more additional work	Reduce problem solving time in routine and non-routine situation
Km is an additional function and a high overhead	Though it is additional function but not provide any benefit
Requires investment in hardware and software	Operational and tacit knowledge doesn't need any investment
People doesn't like to share knowledge	Yes, But it is managed
Knowledge is kept secret	No today's knowledge is a general knowledge of tomorrow
Km is a static system	No it is dynamic
Knowledge is an analytical information, processed for specific goal	Yes it is provide a perfect problem solving mechanism

Knowledge Management Systems architecture



Knowledge Management Systems architecture

- **Identification:**

  in this phase the knowledge definition, scope and category has been defined then surveys and knowledge structure has been build.

- **Knowledge generation:**

  In this step the knowledge manipulation, process and knowledge database has been generated.

- **Knowledge delivery:**

  this step involves knowledge sharing with proper access control with authorization and authentication process.

Knowledge management

- Tools of KM:

- Database management tools
- DW,Data mining and Data mart
- Process modeling and management tools
- Workflow management tools
- Search engine tools
- Web based tools

Unit-5

Transaction Processing Applications – Basic Accounting Application – Applications for Budgeting and Planning – Other use of Information Technology: Automation – Word Processing – Electronic Mail – Evaluation Remote Conferencing and Graphics – System and Selection – Cost Benefit – Centralized versus Decentralized Allocation Mechanism.

A transaction processing system (TPS) is an information system that records company transactions (a transaction is defined as an exchange between two or more business entities).

Types of Transactions

1.Internal Transactions: Those transactions, which are internal to the company and are related with the internal working of any organization. For example Recruitment Policy, Promotion Policy,Production policy etc.

2. External Transactions: Those transactions, which are external to the organization and are related with the external sources, are regarded as External Transaction. For examples sales, purchase etc.

Process of Transaction Processing System

The seven steps in processing a transaction are:

1. Data entry: Keyboard/video display terminals
2. Data Capture: Captures data directly without the use of data media by optical scanning of bar codes printed on product packaging.
3. Data validation: **error detection and error correction, Invalid data, Inconsistent data**
4. Processing and revalidation: **Online transaction processing** online transaction processing are ATM transactions,, in which transactions are accumulated over time and processed identically. Batch processing may be done on a daily, weekly, or monthly basis or any other time period appropriate to the application.
5. Storage: For example, magnetic tape is often used to store data that is Batch processed.oltp magnetic disks. store the result and then output them to the decision maker.
6. Output generation:

1.Documents and reports

2. Forms: screens or panels.

7. Query support: Examples of queries include:

1. Checking on the status of a sales order
2. Checking on the balance in an account
3. Checking on the amount of stock in inventory

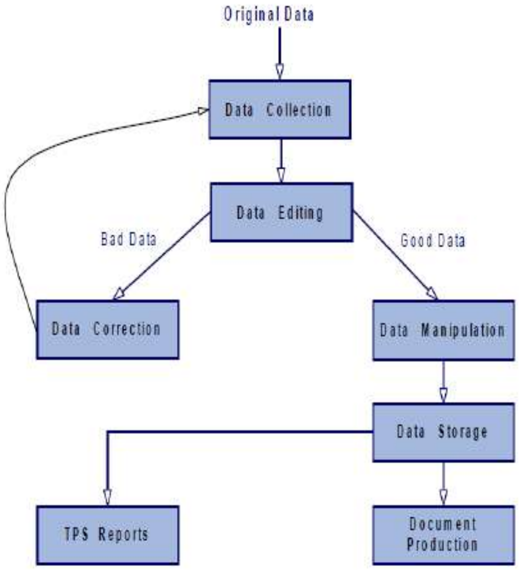


Figure 15: Transaction Processing Activities

Table 5: Functions of MIS

Functions of a MIS in terms of data processing requirements		
Inputs	Processing	Outputs
Internal Transactions	Sorting	Summary reports
Internal Files	Merging	Action reports
Structured data	Summarizing	Detailed reports

Transaction Models

Flat Transaction Model

The flat transaction begins at one consistent database state, and either ends in another consistent state, i.e., the transaction commits, or remains in the same consistent state, i.e., the transaction aborts.

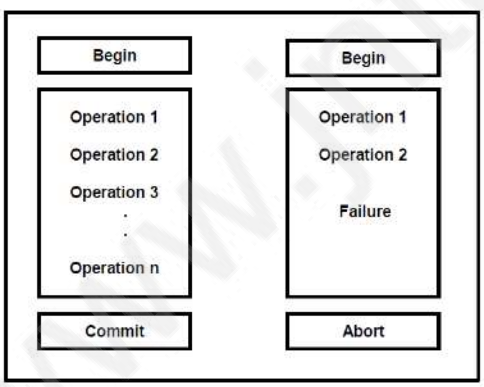


Figure 16: Flat Transaction Model

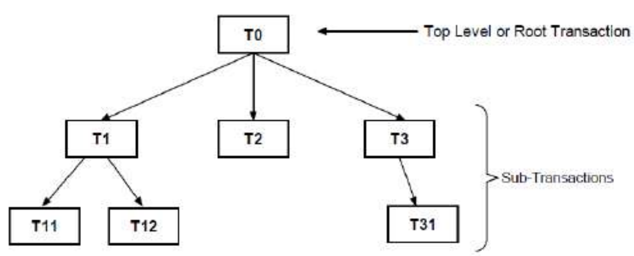


Figure 17: Nested Transaction Model

Nested Transaction Model

The nested transaction model defines the concepts and the mechanisms for breaking up the large building block of a flat transaction into a set of smaller transactions, called sub-transactions. Thus, the nested transaction model has a hierarchical tree structure that includes a top-level transaction and a set of sub-transactions (either parent or children transactions). Sub-transactions at the leaf level of the transaction tree are flat transactions.

Multilevel Transaction Model

This is supported by the concepts of compensating transactions. We will briefly discuss the concept of compensating transactions, and its opposed contingency transactions

Compensating Transactions are designed to undo the effect of the original transactions that have aborted.

Contingency Transactions are designed to replace the task of the original transactions that have failed

Sagas Transaction Model

The Sagas transaction model also makes use of the concept of compensating transactions to support transactions whose execution time is long. A Sagas transaction consists of a consecutive chain of flat transactions Si that can commit independently.

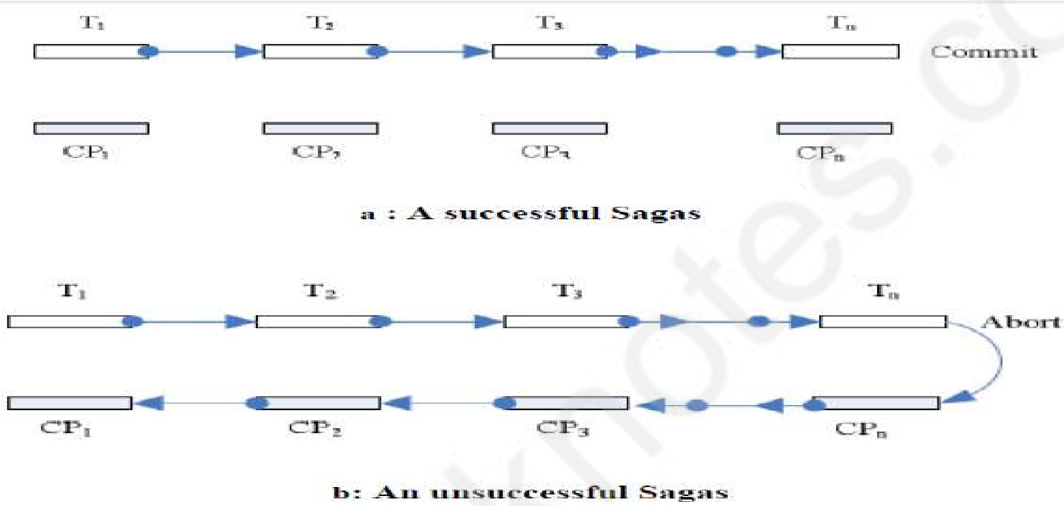


Figure 19: Successful and Unsuccessful Sagas

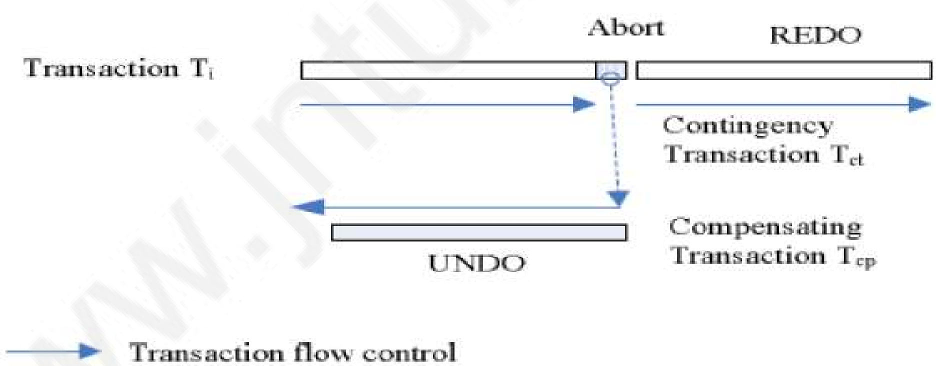


Figure 18: Compensating and Contingency Transactions

Split and Join Transaction Model

The Split and Join transaction model focuses on activities that have uncertain duration, uncertain developments, and are interactive with other concurrent activities. The main idea is to divide an on- going transaction into two or more serializable transactions, and to merge the results of several transactions together as one atomic unit.

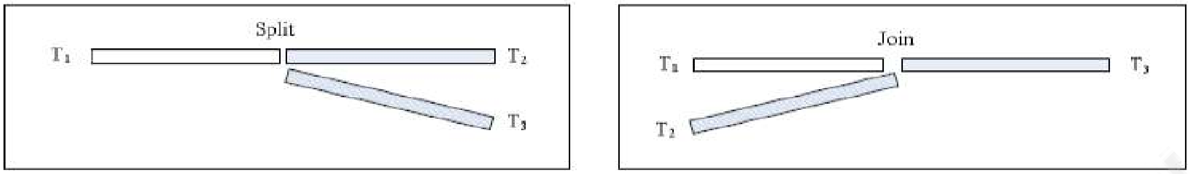


Figure 20: Split and Join Transaction Model

Transactions on a Transaction-Oriented Database System

A transaction processing system plays a role as a mediator that accepts transaction requests from users, dispatches these requests to the database system, coordinates the execution of the involved transactions, and forwards transaction results to the original acquirers.

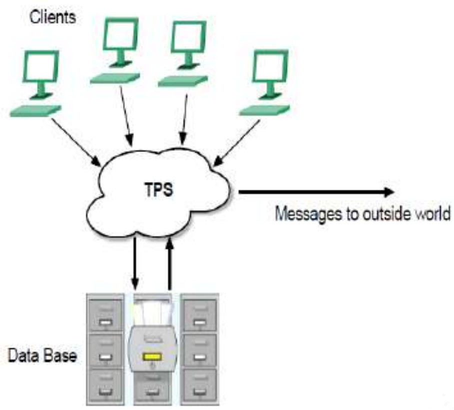


Figure 21: Transaction-oriented database system

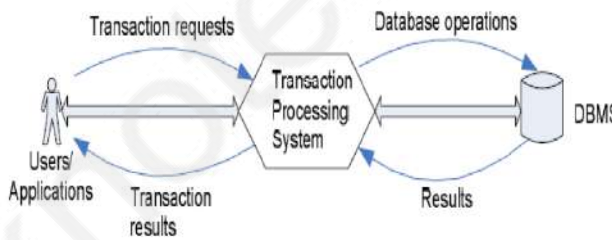


Figure 22: Dataflow of transaction-oriented database systems

MIS converts TPS data into information for monitoring performance and managing an organization. Transactions recorded in a TPS are analyzed and reported by an MIS Management information systems serve the management level of the organization, providing managers with reports and often online access to the organization's current performance and historical records.

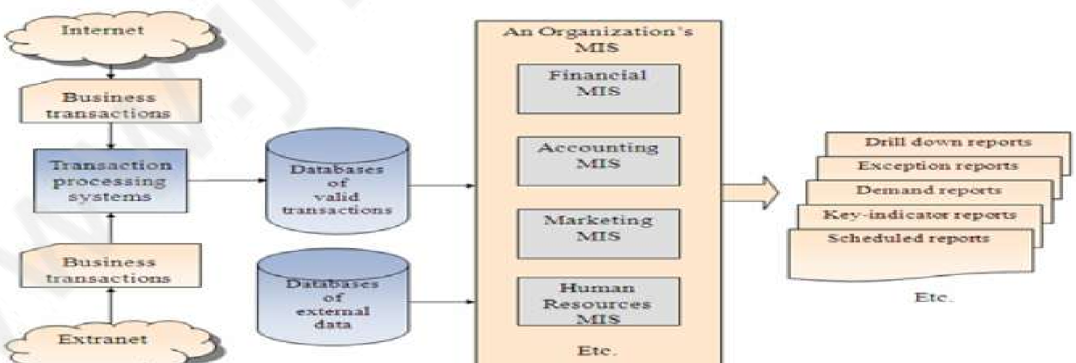


Figure 24: How MIS's obtain their data from the organization's TPS

What are Accounting Information Systems?

An information system is a formal process for collecting data, processing the data into information, and distributing that information to users. The purpose of an accounting information system (AIS) is to collect, store, and process financial and accounting data and produce informational reports that managers or other interested parties can use to make business decisions. Although an AIS can be a manual system, today most accounting information systems are computer-based.

Functions of an Accounting Information System

Accounting information systems have three basic functions:

1. The first function of an AIS is the efficient and effective collection and storage of data concerning an organization's financial activities, including getting the transaction data from source documents, recording the transactions in journals, and posting data from journals to ledgers.
2. The second function of an AIS is to supply information useful for making decisions, including producing managerial reports and financial statements.
3. The third function of an AIS is to make sure controls are in place to accurately record and process data.

Parts of an Accounting Information System

An accounting information system typically has six basic parts:

1. *People* who use the system, including accountants, managers, and business analysts
2. *Procedure* and instructions are the ways that data are collected, stored, retrieved, and processed
3. *Data* including all the information that goes into an AIS
4. *Software* consists of computer programs used for processing data
5. *Information technology infrastructure* includes all the hardware used to operate the AIS
6. *Internal controls* are the security measures used to protect data

Types of accounting information system:

- General ledger system: this module helps organisations leverage the GL processing speeds available streamline accounting processes and reduce the period end close cycle.
- Asset management: this module help streamline tracking, depreciation and maintenance scheduling of asset improve productivity with easier access to critical information derive maximum tax benefits and minimize risk of loss or damage to capital assets. It maintains an inventory of the company's long term assets.
- Order entry system: it captures and manages different kinds of data relating to a transaction such as number of units sold customer billing.
- Account receivable and payable system: this module helps organisations bill customers automatically from any sales channel, streamline accounts receivables processing and automate the invoicing process.
- Inventory control system: it captures processes and manages all issues related to the company's inventory such as items in inventory, inventory cost, lost items and damages items.
- Payroll system: it captures and processes data related to salaries including taxes, other deductions, benefits, overtime and other related data.
- Cash management: this module helps organisations forecast cash flows in any currency and in multiple time periods, streamline the reconciliation process, monitor exceptions and fraud and manage the cash cycle efficiently with control.

<u>office Automation Systems:</u>

- Office automation refers to the application of computer and communication technology to office functions .
- These are meant to improve the productivity of managers at various levels of management by providing secretarial assistance and better communication facilities.
- office activities may be grouped under two classes, namely
    i. activities performed by clerical personnel (clerks, secretaries, typists, etc.)
    ii. activities performed by the executives (managers, engineers Or other professionals economists, researchers, etc.).
- In the first category, the following is a list of activities.(a) Typing, b) mailing, c) scheduling of meetings and conferences d) calendar keeping, and e) retrieving documents.

- The following is a list of activities in the second category (managerial category).
    (a) conferencing,
    (b)production of information (messages, memos, reports, etc.), and
    (c)controlling performance.
- The applications of office automation systems are

❖ **<u>word Processing :</u>**

- This refers to the computer-assisted preparation of documents (like letters, reports, memos, etc.) from textual data.
- Text is entered via a keyboard which is displayed on the screen of a visual display unit. Data once entered can be manipulated in various ways It can be edited, stored on magnetic media and reproduced through simple commands which eliminate the need for redrafting the entire document.
- Spellings can be checked automatically and pre-defined letters can be generated, addressed to many persons by merging the letter and address through a mail-merge program.

❖ **<u>Electronic Filing:</u>**

- this facilitates the filing of incoming and outgoing mail/documents on a magnetic media. Information is captured from the documents and is stored for future reference.
- Computer-based filing systems have the advantage of space saving and permitting easily modifiable cross-reference indexes. These indexes contain pointers to the location of the document itself.

❖ **<u>Electronic Mail :</u>**

- It involves the transfer of letters and other documents through telecommunication lines, rather than through physical delivery.
- An electronic mail system requires a telecommunication network and software. It speeds up mail deliveries and reduces the cost and time taken by paper-mail.
- Voice mail, which is another form of e-mail, transmits messages in digitized voice.

E-mail or electronic mail is the most commonly used Internet service. It refers to the facility of sending and receiving messages electronically over a network of computers. Sending and receiving e-mails require a user to have an e-mail address (sometimes called an e-mail account or an e-mail ID) in any of the Websites that provides e-mail service. A number of Websites, such as www.yahoo.com, www.gmail.com, www.rediffmail.com and www.hotmail.com provide the facility to create free e-mail account. Note that since multiple users can access the Internet at the same time, the e-mail address must be unique for each Internet user.

An e-mail address is divided into two parts, namely the username and the mail server name. The two parts are separated by the symbol @.

The structure of an e-mail address is as follows: username@mailservername.com For example, itl.esl@gmail.com is an e-mail address where, itl.esl = the username gmail = the name of the mail server .com = a commercial Website .

Though e-mail is a very popular service of the Internet because of its numerous advantages, it has few disadvantages also.

The advantages and disadvantages of e-mail are as follows:

Advantages

- It is a very fast medium of communication. The messages can be sent in no time irrespective of the distance.
- It is a very economic medium of communication. You are only charged the cost of being online whether you are sending it overseas or down the road.
- Any form of data, such as text, graphics, sound, or video, can be sent through e-mails.
- It is a secure medium of communication, that is, no one can access anybody's e-mail account without knowing the password.

Disadvantages

- A slight error in the e-mail address of the recipient is enough to prevent the delivery of the message and even when you do everything right, there is always a chance of failure in one of the links between you and your recipient.
- Sometimes, viruses can enter your system through the attachments received in e-mails

Voice Mail and Fax Voice mail and fax are among some of the services provided by telephone service providers. Voice mail allows communicating information in the form of audio, whereas fax allows communicating information in the form of graphics. In both these services, the sender and the receiver need not be present at the same time. The information is sent to a machine which can be viewed by the receiver at his own convenient time.

Voice Mail Voice mail is a service in which the spoken message is converted into digital form, transmitted over a network, and stored on the disk (a voice mailbox) for later retrieval. The recipient is given a message that a new voice mail has been delivered in the mailbox. Whenever the user visits the mailbox, the voice message is restored and played back in audio form. This store and forward technology is very useful because it overcomes the restriction for real-time communication between the machines. Moreover, it facilitates the receiver in saving, deleting and forwarding messages to others. Voice mail can be helpful in automated call return, message forwarding, message broadcasting, etc. It is now being used for advertising also. It is more commonly used by school authorities for informing the guardians about the progress, attendance, etc., of the students.

Fax Fax (facsimile) system is used for transferring a copy image of any document. Fax transmission involves fax machines with inbuilt modems at both the ends connected with telephone network. The fax machine at the sender's side scans the image from top to bottom and from left to right, looking for black and white dots. These dots are then translated into data bits which are transmitted over the network through modem and reproduced in a hard copy by the fax machine at the receiver's side.

Teleconferencing

Teleconferencing is a technology that allows communication among several people at distant locations but connected via the telecommunications system, usually over a telephone line. It is similar to a telephone call but the conversation is extended to several people instead of only two. Thus, it can reduce the travelling cost, increase idea sharing with each other, and result in improved quality and increased productivity. A business organization uses teleconferencing to connect to its remote clients and employees. Teleconferencing enables organizations to arrange meetings, demonstrate their product, present project updates, and even provide live training classes to various employees at remote locations. In addition, it can also be used to report monthly progress.

The simplest form of teleconferencing is to use the three-way calling service provided by the telephone companies. This service enables you to establish your own teleconference between yourself and the other two persons. Some of the teleconferencing service providers provide this service for more than three persons. Since it is low cost, most companies use teleconferencing service provided by the telephone companies rather than setting up their own teleconferencing systems.

The traditional mode of teleconferencing enables only voice sharing among the participants, but modern teleconferencing technologies, namely data conferencing and video conferencing, help in sharing information from both the ends simultaneously. While data conferencing allows sharing electronic documents with each other, video conferencing enables the participants to see each other, in addition to information sharing.

Data Conferencing

Data conferencing is a type of teleconferencing that allows sharing of computer data, such as graphics, drawings, documents, screen, applications, etc., interactively among multiple users at remote locations. All the participants can view the data, comment on it or manipulate it. In data conferencing, devices like keyboard, screen, mouse, etc., can be shared among the participants or one participant's computer can control other participants' computers.

Data conferencing is performed with the help of whiteboards, application sharing, and application viewing.

- Whiteboard: It is an online workspace visible to everyone participating in data conferencing. All the participants can simultaneously write and draw on the whiteboard and the changes made are viewed by everyone. Whiteboard employs different tools to support drawing and writing.
- Application Sharing: It is like remote control software that allows the participants at the remote machines to interactively work on an application installed on only one participant's machine.
- Application Viewing: It is similar to application sharing except that only one participant is allowed to make changes in the shared document while others can only view the document and provide suggestions.

Interactive Video/Video Conferencing

Video conferencing enables conversation among people geographically apart from one another with a facility to see each other while they converse. The newsreader on the TV, for example, talking to a reporter(s) at a faraway place(s) and reporting directly to the audience, uses the video conferencing facility. Video conferencing is an extremely useful means of communication because it saves the time and expense of travel and can often accomplish many of the things that a physical meeting can. The five basic components that are required to conduct a video conferencing are as follows:

- Camera: To capture the images to be sent across the network.
- Monitor or Television: To display the images of the people participating in the video conference.
- Microphone: To record the sound at the sender's end.
- Speakers: To play the recorded sound at the receiver's end.
- Coder/Decoder (Codec): To compress and decompress video and audio data, allowing transmission across the network.

Cost Benefit

Cost benefit analysis: What is it?

A cost benefit analysis (also known as a benefit cost analysis) is a process by which organizations can analyze decisions, systems or projects, or determine a value for intangibles. The model is built by identifying the benefits of an action as well as the associated costs, and subtracting the costs from benefits. When completed, a cost benefit analysis will yield concrete results that can be used to develop reasonable conclusions around the feasibility and/or advisability of a decision or situation.

Scenarios Utilizing Cost Benefit Analysis

As mentioned previously, cost benefit analysis is the foundation of the decision-making process across a wide variety of disciplines. In business, government, finance, and even the nonprofit world, cost benefit analysis offers unique and valuable insight when:

- Developing benchmarks for comparing projects
- Deciding whether to pursue a proposed project
- Evaluating new hires
- Weighing investment opportunities
- Measuring social benefits
- Appraising the desirability of suggested policies
- Assessing change initiatives
- Quantifying effects on stakeholders and participants

How to Do a Cost Benefit Analysis

While there is no "standard" format for performing a cost benefit analysis, there are certain core elements that will be present across almost all analyses. Use the structure that works best for your situation or industry, or try one of the resources and tools listed at the end of this article. We'll go through the five basic steps to performing a cost benefit analysis in the sections below, but first, here's a high-level of overview:

1. Establish a framework to outline the parameters of the analysis
2. Identify costs and benefits so they can be categorized by type, and intent
3. Calculate costs and benefits across the assumed life of a project or initiative
4. Compare cost and benefits using aggregate information
5. Analyze results and make an informed, final recommendation

Identify and Categorize Costs and Benefits

In cost/benefit evaluation of the various expected costs, the benefits to be expected from the system and expected savings is done. The cost/benefit analysis determines the cost-effectiveness of the system. The various categories of costs and benefits are measured and included in cost/benefit analysis.

i) **Initial development cost** : it is the cost of developing an information system. The various elements of development cost include project planning cost, feasibility study cost, testing costs, implementation cost etc.

ii) **Capital cost** : It is also a one time cost. It is the cost of providing facilities and equipments including hardware etc for the operation of the system.

iii) **Annual operating cost** : It is the cost of operating the system. It includes computer and equipment maintenance cost, personnel cost overheads and supplies cost. Computers and equipment are to be maintained and thus some cost is included, known as Annual Maintenance Cost.

In cost/benefit evaluation, various expected beenfits from the system are also studied. The first task is to identify each benefit and then assign a monetary value to it. Benefits may be tangible or intangible, direct or indirect.

Now that your framework is in place, it's time to sort your costs and benefits into buckets by type. The primary categories that costs and benefits fall into are **direct/indirect**, **tangible/intangible**, and **real**:

- **Direct costs** are often associated with production of a cost object (product, service, customer, project, or activity)
- **Indirect costs** are usually fixed in nature, and may come from overhead of a department or cost center
- **Tangible costs** are easy to measure and quantify, and are usually related to an identifiable source or asset, like payroll, rent, and purchasing tools
- **Intangible costs** are difficult to identify and measure, like shifts in customer satisfaction, and productivity levels
- **Real costs** are expenses associated with producing an offering, such as labor costs and raw materials

Benefits might include the following:

- Revenue and sales increases from increased production or new product.

- Intangible benefits, such as improved employee safety and morale, as well as customer satisfaction due to enhanced product offerings or faster delivery.
- Competitive advantage or market share gained as a result of the decision.

Finally, the results of the aggregate costs and benefits should be compared quantitatively to determine if the benefits outweigh the costs. If so, then the rational decision is to go forward with the project. If not, the business should review the project to see if it can make adjustments to either increase benefits or decrease costs to make the project viable. Otherwise, the company should likely avoid the project.

Centralization and Decentralization

Centralization and Decentralization are the two types of structures, that can be found in the organization, government, management and even in purchasing. **Centralization** of authority means the power of planning and decision making are exclusively in the hands of top management. It alludes to the concentration of all the powers at the apex level.

On the other hand, **Decentralization** refers to the dissemination of powers by the top management to the middle or low-level management. It is the delegation of authority, at all the levels of management.

Definition of Centralization

A pivot location or group of managerial personnel for the planning and decision-making or taking activities of the organization is known as Centralization. In this type of organization, all the important rights and powers are in the hands of the top level management.

In earlier times, centralization policy was the most commonly practiced in every organization to retain all the powers in the central location. They have full control over the activities of the middle or low-level management. Apart from that personal leadership and coordination can also be seen as well as work can also be distributed easily among workers.

However, due to the concentration of authority and responsibility, the subordinate employee's role in the organization is diminished because of all the right vests with the head office. Therefore, the junior staff is only to follow the commands of the top managers and function accordingly; they are not allowed to take an active part in the decision-making purposes. Sometimes hotchpotch is created due to excess workload, which results in hasty decisions. Bureaucracy and Red-tapism are also one of the disadvantages of centralization.

Definition of Decentralization

The assignment of authorities and responsibilities by the top level management to the middle or low-level management is known as Decentralization. It is the perfect opposite of centralization, in which the decision-making powers are delegated to the departmental, divisional, unit or center level managers, organization-wide. Decentralization can also be said as an addition to Delegation of authority.

At present, due to the increase in competition, managers take the decision regarding for the delegation of authority to the subordinates. Due to which the functional level managers get a chance to perform better, as well as freedom of work, is also there. Moreover, they share the responsibility of the high-level managers which results in quick decision making and saving of time. It is a very effective process for the expansion of the business organization, like for mergers and acquisitions.

BASIS FOR COMPARISON	CENTRALIZATION	DECENTRALIZATION
Meaning	The retention of powers and authority with respect to planning and decisions, with the top management, is known as Centralization.	The dissemination of authority, responsibility and accountability to the various management levels, is known as Decentralization.
Involves	Systematic and consistent reservation of authority.	Systematic dispersal of authority.
Communication Flow	Vertical	Open and Free
Decision Making	Slow	Comparatively faster
Advantage	Proper coordination and Leadership	Sharing of burden and responsibility
Power of decision making	Lies with the top management.	Multiple persons have the power of decision making.
Implemented	Inadequate control over	Considerable control over the

BASIS FOR COMPARISON	CENTRALIZATION	DECENTRALIZATION
when	the organization	organization
Best suited for	Small sized organization	Large sized organization

UNIT-6

Development And Maintenance Of Information Systems
Systems analysis and design – System development life cycle – Limitation – End user Development – Managing End Users – off– the shelf software packages – Outsourcing – Comparison of different methodologies.

Once the development of MIS is complete, it is ready for implementation. Implementation is a process of installing a newly-developed MIS at the user's premises and continuously getting the output it was designed to generate. In other words, it is the process of converting from an old system to a new system. Implementation means putting the new system into operation.

IMPLEMENTATION PROCESS

- Implementation of MIS is a process in itself and involves various steps.
- It is understood here that the major steps are based on the design specifications.
- All requirements of the system, such input, processing, output, equipment, personnel, etc., are provided by the design specifications.

The various steps are as follows.

1. ***Planning the Implementation:***

- The first step in the implementation of an MIS is to plan it. For proper implementation, the plan is a pre-requisite and is known as pre-implementation activity.
- Various activities, which are required for implementing a system, are identified and their sequence and relation to each other is decided. In this step, various other estimates like time required for each activity and cost estimates are also obtained.
- To describe the plan schedule, a system analyst should make use of various tools like Gantt Charts, Network Diagrams, etc.

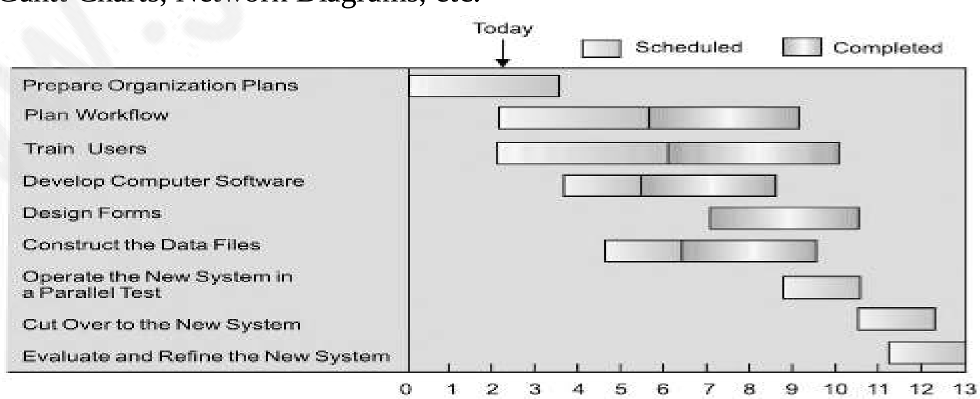
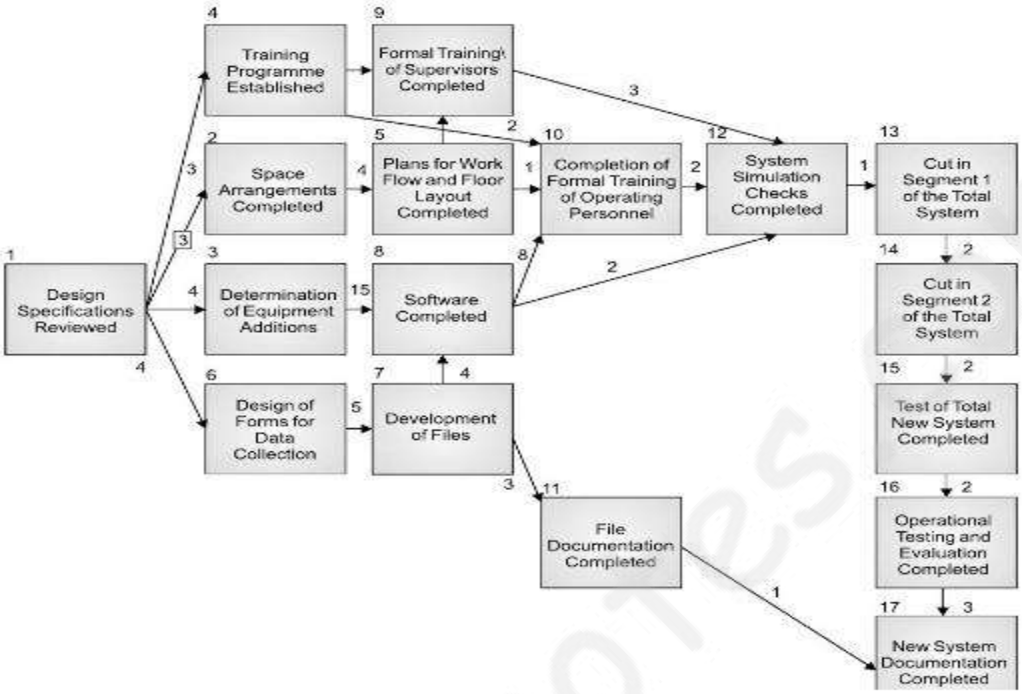


Figure 14.1 Gantt Chart – An Example



2. ***Acquisition of Facilities and Space Planning***
   - The information system to be implemented may be for a new organisation, where no old system is in existence or for an existing organisation, the information system has been modified to a great extent or altogether a new one has been developed. This requires acquisition of facilities like office, computer room, computer library, etc.
   - For proper implementation of the system, the MIS manager is required to prepare estimates of floor space requirements and also rough layouts.
   - Space planning should take into account the space occupied by computers, terminals, printers, etc., as also by people and their movement.
3. ***MIS Organisation and Procedure Development***
   - It is also important that a manager be given the responsibility of guiding the task of implementation.
   - The appointed MIS manager must make users clear and ensure their involvement in the system to the maximum extent possible. In other words, the users should develop a feeling as if the system is their ownsystem.
4. ***User Training***
   - Adequate user training is very important for successfully implementing an information system. The users may be identified and classified differently on the basis of the operations/functions performed by them.
   - The MIS manager must design training programs as per the needs of these users.

5. ***Acquisition of Hardware and Software***
    - The process of acquiring the necessary hardware and software should start immediately after the design specifications of the system are over.
    - selecting hardware and software is quite complex and time-consuming .It should be ensured that the facilities which are required for installing the hardware site preparation work, computer room layout, air-conditioning, electric connections, etc., should be complete to avoid loss of time in making the system operational.
6. ***Creation of Forms and Database***
    - Forms are very important for transmitting data. They are also required for input to the system and output from the system.
    - For implementation of MIS, the required forms should be generated, care must be taken that these are generated in the context of the entire MIS.
    - Similarly, in the implementation stage, the actual data should be obtained and the database created, which is used, in the first instance, for the initial testing and then for the actual operation of information system.
7. ***Testing***
    - Tests should be performed in accordance with the test specifications at each and every phase. it is more important at implementation because, testing at this stage is done under real operating conditions with factual data.
    - Testing can be done with only a small representative data but it should be done at various levels, starting from elements to sub-systems and finally to the system as a whole.
    - These tests are performed mainly for accuracy, range of inputs, frequency of inputs, operating conditions and reliability, etc.
    - Testing of information systems can be undertaken with the help of Computer Aided Sotware Engineering (CASE) tools. These tools provide for online debugging for correcting program and data errors.
8. ***Changeover***
    - Changeover is the event of switch-over from the old system to the new system, Which takes place after the system is tested and found reliable.
    - The existing system is replaced by the new system . Conversion from the old system to the new system may be accomplished by selecting combination of various conversion approaches.

    i. ***For New Organisation/Operation:***

    - If the organisation is a new one or when the old system does not exist, there is only one method for implementing the newly developed system, i.e. install the system.

- The newly developed system is implemented as there is no old system in operation and thus no question of replacement of the old or existing system arises.

ii. ***For Existing Organisation/Operation***

- when the old system is in existence, there may be four different strategies, namely:
  - *a. Direct*
  - *b. Parallel*
  - *c. Modular*
  - ***d.*** *Phase-in*

a. Direct Approach

- A direct implementation is the installation of the new system and the immediate discontinuation of the old system, sometimes called cutoff.
- This is the 'Cold Turnkey' approach. This approach produces a time gap when no system is working.

This approach is meaningful when

(a) the system is not replacing any other system,

(b) the old system is judged absolutely worthless,

(c) the new system is either very small or simple, and

(d) the design of the new system is drastically different from that of the old system and comparisons between systems would be meaningless.

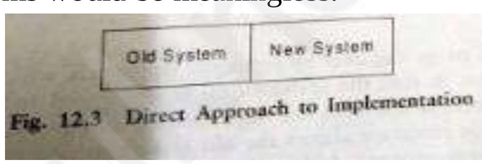
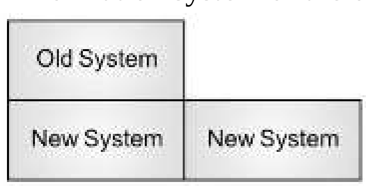


Fig. 12.3 Direct Approach to Implementation

b. Parallel Approach

- In this approach, the new system is installed and operated in parallel with the current system until has been tested thoroughly; then the current system is cutout. This is the opposite of the direct implementation approach.
- In a parallel implementation approach, the outputs from each system are compared and differences reconciled. This method is expensive because of duplicating facilitiesand personnel to maintain the dual systems.
- it is required in certain essential systems, such as payroll, examination and defence systems. Its main advantage is that the accuracy of the system is properly checked before it is accepted as an information system of the organisation,



c. Modular Approach

- Modular approach, sometimes termed the 'pilot approach', refers to the implementation of a system in the organisation on a module basis.
- For example, an inventory system might be implemented with only a selected product grouping or with all products in one location of a multiple-location organisation.

This approach has the following advantages.

(a) The risk of a system's failure is localised.

(b) The problems identified in the system can be corrected before further implementation.

(c) Other operating personnel can be trained in a 'live' environment before the system is implemented at their location.

Figure 14.5 Modular Approach to Implementation

d. Phase-in Implementation

- This method is also referred to as 'cut over by segments' approach, similar to the modular approach. it differs in that the system itself is segmented and not the organisation.
- The advantages of this approach are that the rate of change in a given organization can be minimized and data processing resources can be acquired gradually over an extended period of time.
- This method is most-suited for systems which require only up gradation of the old systems.
- The disadvantages to this approach include the costs incurred to develop temporary interfaces to old systems, limited applicability and a feeling of pendency in the organization.
- Proper feedback is required to be received continuously for doing corrective adaptive and perfective, maintenance.
- Evaluation of the newly-developed and implemented system is required to be made to know the quality of the system developed and to get a continuous feedback on the performance of the information system.

Old System	
Function (a)	Function (b)
Old	New

Figure 14.6 Phase-in Implementation

SYSTEM ANALYSIS

INTRODUCTION:

System analysis may be understood as a process of collecting and interpreting facts, identifying problems and using the information to recommend improvements in the system.

In other words, system analysis means identification, understanding and examining the system for achieving predetermined goals/objectives of the system.

System analysis is carried out with the following two objectives.

i) to know how a system currently operates, and

ii) to identify the users requirements in the proposed system.

The system analysis phase is very important in the total development efforts of a system. The user may be aware of the problem but may not know how to solve it. During system analysis, the system designer works with the user to develop a logical model of the system.

A system analyst, because of his technical background, may move too quickly to program design to make the system prematurely physical, which is not desirable and may affect the ultimate success of the system.

REQUIREMENT DETERMINATION :

Requirement determination, which is also termed as a part of software requirement specification (SRS) is the starting point of the system development activity.

This activity is considered as the most difficult and also the most error-prone activity because of the communication gap between the user and the developer. This may be because the user usually does not understand software and the developer often does not understand the users problem and application area.

The requirement determination is a means of translating the ideas given by the user, into a formal document, thus to bridge the communication gap. A good SRS provides the following benefits.

(i) It bridges the communication gap between the user and the developer by acting as a basis of agreement between the two parties.

(ii) It reduces the development cost by overcoming errors and misunderstandings early in the development.

(iii) It becomes a basis of reference for validation of the final product and thus acts as a benchmark.

Requirement determination consists of three activities, namely,

- requirement anticipation,
- requirement investigation and
- requirement specification.

Requirement anticipation activities include the past experience of the analysis, which influence the study.

Requirement investigation is at the centre of system analysis. In this, the existing system is studied and documented for further analysis. Various methods like fact-finding techniques are used for the purpose.

Requirement specification activities, the data produced during the fact-finding investigation is analysed to determine requirement specification, which is the description of the features for a proposed system.

Requirement determination is to learn and collect the information about

(a) The basic process,
(b) The data which is used or produced during that process,
(c) The various constraints in terms of time and the volume of work, and
(d) The performance controls used in the system.

Let us discuss these activities in more detail.

a. Understanding the Process

Process understanding can be acquired, if the information is collected regarding

- the purpose of the business activity,
- the steps, which and where they are performed,
- the persons performing them, and
- the frequency, time and user of the resulting information.

b. Identify Data Used and information Generated:

After process understanding, information analyst should find out what area is used to perform an activity.

For example, if we consider inventory system, the buyer require data about quantity of an item, supplier name, item cost and demand of the item.

c. Determine Frequency, Timing and Volume

Information should also be collected to know how often the activity is repeated and volume of items to be handled. Timing, frequency and volume of activities are important facts to collect.

d. Know the Performance Controls

System controls, enable analyst to understand how business functions can be maintained in an acceptably manner. During system investigation, information is gathered mainly from personnel and written documents from within the organizations environment, which includes financial reports, personnel documents and various other types of documents like transaction documents, manuals, etc.

System analysis consists of two main activities.

(1) Studying the business operations to understand the existing system.
(2) To make an analysis of the information gathered to determine information requirements of the manager in the proposed system.

STRATEGIES FOR REQUIREMENT DETERMINATION

There are different strategies to collect information so as to study the existing system and to determine information, requirement. The strategies are discussed below:

1) Interview

- The interview is a face-to-face method used for collecting the required data. In this method, a person (the interviewer) asks questions from the other person being interviewed. The interview may be formal or informal and the questions asked may be structured or unstructured.

- The interview is the oldest and the most often used device for gathering information about an existing system. Although it is one of the preferred techniques, interviewing is not always the best source of application data.
- Because of the time required for interviewing and the inability of the users to explain the system in detail, other methods are also used to gather information. However, this method is helpful for gathering information from individuals who do not communicate effectively in writing or who may not have the time to answer questionnaires.
- Interviews allow analysts to discover areas of misunderstanding, unrealistic expectations and even indications of resistance to the proposed system.
- The analyst must plan the interviews and must know clearly in advance regarding the following issues.
  - (i) Whom to interview?
  - (ii) When to interview?
  - (iii) What to ask?
  - (iv) Where to hold the interview?
  - (v) How to begin the interview?
  - (vi) How to conclude the interview?

2)Questionnaire

- The use of questionnaires allows analysts to collect information about various aspects of a system from a large number of persons. The questionnaire may contain structured or unstructured questions.
- The use of a standardized questionnaire may give more reliable data than other fact-finding techniques.
- The questionnaire survey also helps in saving time as compared to interviews. However, this method does not allow analysts to observe the expressions or reactions of respondents.
- The analyst should know the advantages and disadvantages of structured as well as unstructured questionnaires. Questionnaires must be tested and modified as per the background and experience of the respondents.

3) Record Review

- Record review is also known as review of documentation. Its main purpose is to establish quantitative information regarding volumes, frequencies, trends, ratios, etc. In record review, analysts examine information that has been recorded about the system and its users.
  - Records/documents may include written policy manuals, regulations and standard operating procedures used by the organization as a guide for managers and other employees. Procedures, manuals and forms are useful sources for the analyst to study the existing system.
  - The main limitation of this approach is that the documentation on the existing system may not be complete and up-to-date.
  - It may be noted here that there are two different views regarding the study of the existing system. One view, which favours the study of the existing system, is that through study of the existing system, one learns about its shortcomings and may use this knowledge to avoid committing the same mistakes again, Whereas the view which is against such a study, argues that it inhibits the generation of

new ideas and may bias the developer towards the same logic which is contained in the old system.

- It is difficult to comment upon the two views. However, both the views seem valid. It can only be suggested here that an information analyst should study the existing system, if any, to know more about the whole of the system.

4) Observation

- Another information-gathering tool used in system studies is observation. It is the process of recognizing and noticing people, objects and occurrences to obtain information.
- Observation allows analysts to get information, which is difficult to obtain by any other fact-finding method. This approach is most useful when analysts need to actually observe the way documents are handled, processes are carried out and whether specified steps are actually followed.
- As an observer, the analyst follows a set of rules. While making observations, he/she is more likely to listen than talk. The exercise is time-consuming and costly. Also the observer may not be able to get all the required information, especially about some intricacies of the system.

STRUCTURED ANALYSIS TOOLS:

Structured analysis tools help the system analyst to document the system specification of a system to be built.

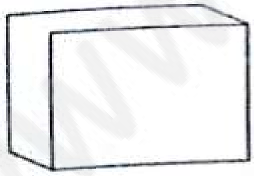
The main tools which are used for the purpose are given below.

(i) Data Flow Diagram (DFD)
(ii) Data Dictionary
(iii) Structured English
(iv)Decision Trees
(v) Decision Tables

Data Flow Diagram (DFD)

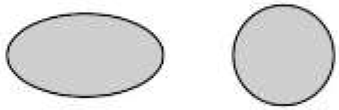
- Data Flow Diagram (DFD) is a graphical representation of the logical flow of data. It helps in expressing the system's requirements in a simple and understandable form. It is also known as a bubble chart.
- Its aim is to clarify the system requirements and identify major transformations that will become programs in system design.
- A DFD consists of a series of bubbles joined by lines representing data flow in the system. There are four main symbols used in a DFD, which are depicted below.

(1) Square; It represents source destination of system data.

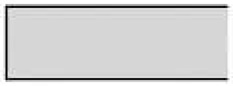


(ii) Arrow: It identifies data flow; it is a pipeline through which the data flows.

(iii) Circle/Bubble: It represents a process that transforms incoming data flow into outgoing data flow. A process can be represented by a circle or an oval bubble.



(iv) Open Rectangle: It represents a data store.



A number of rules are to be followed in drawing a DFD:
(i) Processes should be named and numbered. Name should represent the process.
(ii) The direction of flow is from top to bottom and from left to right.
(iii) When a process is exploded into lower levels, they are numbered properly, e.g. the process obtained from the explosion of process number 5, should he numbered as 5.1, 5.1, etc.
(iv) The name of data stores, sources and destinations are written in capital letters. Process and data flow names have the first letter capitalized.

- A DFD should have no more than 10-12 processes, as having even 12 will make a DFD complex and difficult to understand.
- A DFD shows the minimum contents of a data store. Each data store should contain all the elements that flow in and out of it.
- DFD is very effective, when the required design is not clear and the user and the analyst require some symbolic representation for communication.
- The main disadvantage of a DFD is that a large number of iterations are often required to arrive at an accurate and complete solution.
- For example, consider the case of a payroll system to prepare salary statements for each employee of an organization. Data flow for such a system can be represented, as shown in below figure.

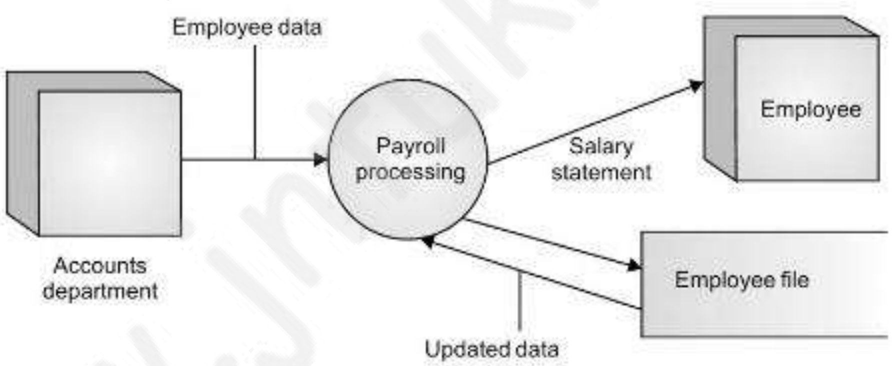
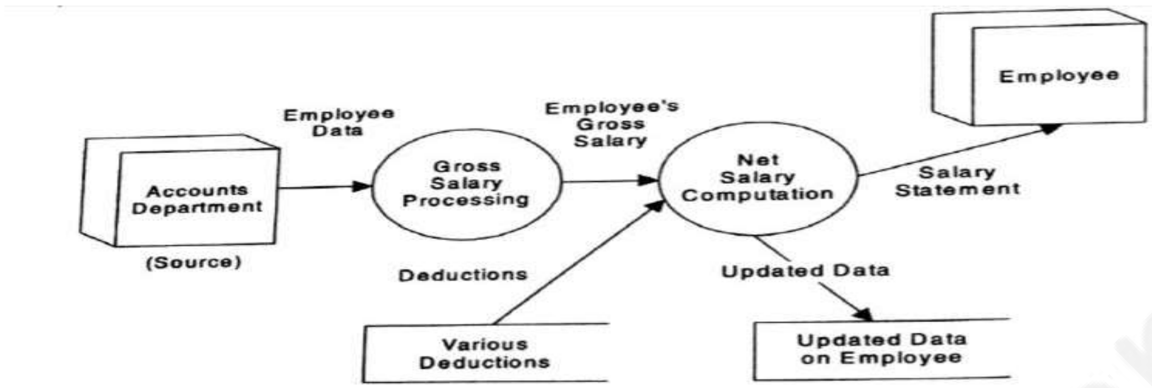


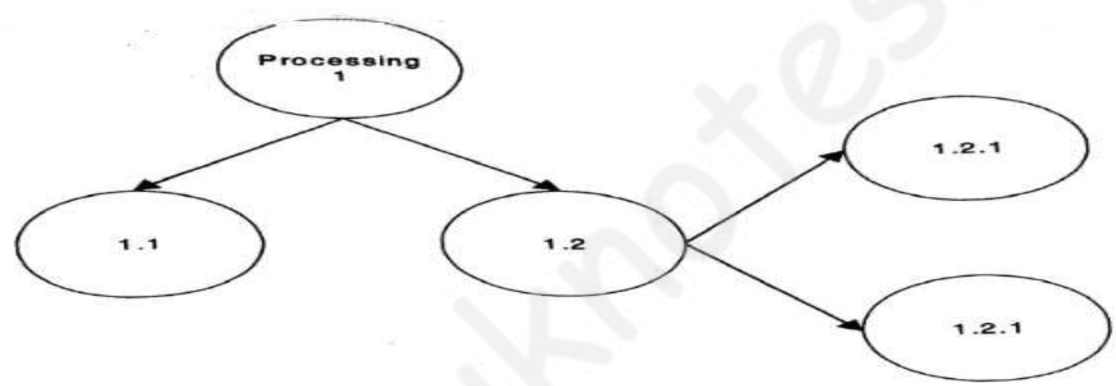
Figure 13.2 A DFD Payroll Processing: Macro View

- Employees data originate from accounts departments (source), gets processed, salary statements received by employees (sink) and updated data on employees (e.g. total tax deducted, providen tfund contribution, etc.) is stored in an intermediate file (data store), which is required for processing in the subsequent months.
- A DFD displays data flow in a top- it down approach. To draw a DFD, start with a macro DFD (overview) and then explode t into micro DFDs. Below figure illustrates the method.



A DFD for Payroll Processing: Exploded View

While exploding a DFD into lower levels, continuity and linkage is maintained between a DFD and its member DFDs. This is achieved by numbering each circle (processing step) by adopting the numbering system, eg. 1, 2, 3,. . ., each further numbered as 1.1, 1.2, 1.3, and still numbered as 1.1.1, 1.1.2, . . .below Figure illustrates the point.



Explosion of a DFD

<u>Data Dictionary</u>

- Data dictionary is a structured repository of data, about data. In other words, it is a set of precise and accurate definitions of all DFDs, data elements and data structures. It supports documentation in a better way. It also improves communication between the user and analyst as it provides precise and consistent definitions for various data elements, terms and procedures.
- There are mainly three items of data present in a data dictionary.
  (i) Data Element: It is the smallest unit of data and cannot be decomposed further.
  (ii) Data Structures: It is a group of data elements handled as a unit. A data structure contains a number of data elements as its fields)
  (iii) Data Flows and Data Stores: Data flows are nothing but data structures in motion, whereas data stores are data structures at rest. In other words, data stores are locations where data structures are temporarily stored. Data dictionary is an integral part of the structured specifications.

The following rules are followed in constructing a data dictionary.

(i) The terms used to describe data structures are always in capital letters.

(ii) Multiple word names are hyphenated.

(iii) Assigned names should be straightforward and user-oriented.

(iv) There should be names for every data flow, data store, data structure and data element.

(v) Consistency checks should be performed.
(vi) Identification numbers of the processes and their names should be mentioned in the data dictionary.
(vii) Aliases must be discouraged.
Various symbols which are used in data dictionary are shown in below table:

Table 13.1 Symbols Used in Data Dictionary

Symbol	*Meaning*
=	is equivalent to
+	add
[Option 1 Option 2 : :]	only one of the options is used at a given time
max {Component} min	Iteration of the component min = lowest possible number of iterations max = highest possible number of iterations
(COMPONENT)	Component is an optional one
Comment	Words within asterisks are comments

Example:

VENDOR-INVOICE
= INVOICE-NUMBER + VENDOR-NAME + TOTAL-INVOICE-AMOUNT +
INVOICE-DUE-DATE + (SHIPPING-DATA)
30
{ ITEM-DETAIL-LINE }
1
One extra copy may be kept

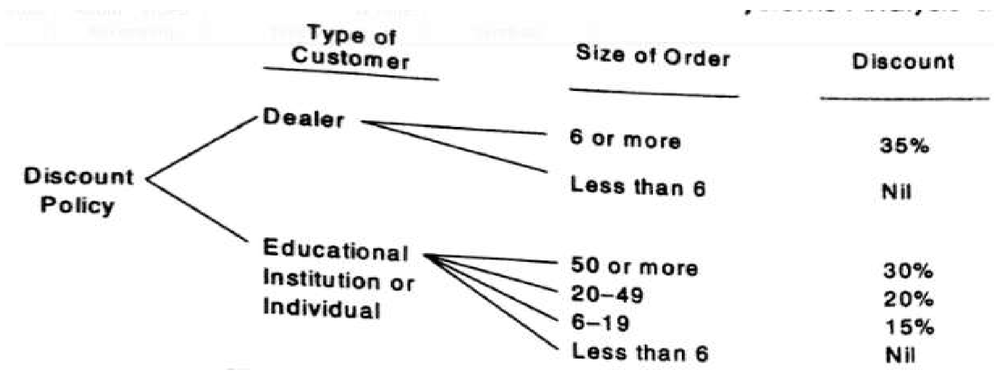
Decision Tree and Structured English

The logic of the process, which may not be very clear through DD, can easily be represented using a graphic representation, which looks like the branches of a tree, called decision tree. A decision tree has as many branches as there are logical alternatives. It is easy to construct, read and update.

Example: The following example illustrates discount policy of a computer dealer.

Computer dealers get a trade discount of 35 per cent if the order size is 6 or more PCs. For orders from educational institutions and individuals, 15 per cent discount is allowed on orders of 6–19 PCs, per PC type; 20 per cent on orders for 20–49 PCs; and 30 per cent on orders for 50 PCs or more, per PC type.

a



Structured English uses the terms in data dictionary. It uses logical construction and imperative sentences . Decisions are made through if-then-else statements

```
MINIMUM        :        5 or less Personal Computers, per PC type
SMALL          :        6 to 19 PCs
MEDIUM         :        20 to 49 PCs
LARGE          :        50 or more PCs

   DISCOUNT-POLICY
   Add up the number of PCs per PC type
   If order is from a dealer
   and—If ORDER-SIZE IS SMALL OR MEDIUM OR LARGE
                THEN: Discount is 35%
   ELSE (ORDER-SIZE IS MINIMUM)
                So: no discount is allowed
   ELSE (ORDER is from educational institution or individual customers)
   SO—IF ORDER-SIZE IS LARGE
                Discount is 30%
   ELSE IF ORDER-SIZE IS MEDIUM
                Discount is 20%
   ELSE IF ORDER-SIZE IS SMALL
                Discount is 15%
   ELSE (ORDER-SIZE IS MINIMUM)
                So: no discount is allowed.
```

Figure 13.6 Structured English – An Example

Decision Table:

- Decision table is a matrix of rows and columns that shows conditions and actions. Decision rules state the procedure to be followed when certain conditions exists.
- Decision tables are best suited for dealing with complex branching routines, e.g. inventory control, etc
- A decision table consists of four sections. A condition stub at the upper left, a condition entry at the upper right, an action stub at lower left, and an action entry at the lower right.

Condition Stub	*Condition Entry*
Action Stub	Action Entry
Stub	Entry

Figure 13.7 A Decision Table

Questions are listed in the condition stub and the action stub outlines the action to be taken to meet each condition.

In constructing a decision table, the following rules are observed.

(i) A decision should be given a name to be written at the top left of the table.
(ii) The logic should he independent of the sequence in which the condition rules were written, but the actions take place in the order in which the events occur.
(iii) Consistent and standardized language should be used.
(iv) Duplication of terms should be avoided to the maximum extent.

A decision table of the earlier problem is constructed in Fig. 11.7.

Condition Stub	Condition Entry					
	1	2	3	4	5	6
Is the customer a dealer?	Y	Y	N	N	N	N
Is the order size 6 PCs or more?	Y	N	N	N	N	N
Is the customer educational institution or inidividual?			Y	Y	Y	Y
Is the order size 50 or more PCs?			Y	N	N	N
Is the order size 20 to 49 PCs?				Y	N	N
Is the order size 6 to 19 PCs?					Y	N
Action Stub	**Action Entry**					
Allow 35% discount	X					
Allow 30% discount			X			
Allow 20% discount				X		
Allow 15% discount					X	

Fig. 11.7 Decision Table – An Example

SYSTEM DESIGN

System design is another important step in the system development process. This phase starts after the system analysis phase is over. In other words, the output of the system analysis phase, i.e. specifications become an input put in the design phase.

DESIGN OBJECTIVES

A system is designed with the following main objectives.

practicality The system should be designed in such a way that it may be learnt and operated with ease by the users. Thus, the design should be user-oriented.

Flexibility The business organizations are dynamic in nature. Therefore, a system must be responsive to the change inevitably requested by its users.

Efficiency A system must be efficient, i.e. it should perform jobs within their specified time.
The efficiency of a system may be measured in terms of the following parameters.
(i) Throughput: It is the ability to handle a specified number of jobs per unit of time.
(ii) Response time: The ability to respond to a request made by the user within a given time limit.
(iii) Run time: It is the ability to undertake the complete job within a given time limit.

Security

This aspect relates to hardware reliability, physical security of data and the detection and prevention of fraud and abuse of data.

System design is carried out at two levels, namely conceptual level and physical level, known as conceptual desi n and physical design, respectively. These two phases are also called external design or general sign and internal design or detailed design.

CONCEPTUAL DESIGN

It is in the conceptual design stage that alternative overall MIS designs are conceived and the best one is selected by the system analyst in consultation with the top management.

Conceptual design involves the following steps:

1. Define problem
2. Set system objectives
3. Identify Constraints
4. Determine information needs
5. Determine information sources
6. Develop various designs
7. Document the conceptual design
8. Prepare report

1) Define Problem

The first step in conceptual MIS design is to clearly understand and define the problem to be solved. It should be noted here that these are not only the current problems, which are of concern rather MIS design should be related to long range planning for the organization.

2) Set System Objectives

While setting system objectives, it must be kept in mind that the value of an information system lies in the benefits to its users. Thus, mere efficiency of the system would not serve the purpose. However, it is very difficult to set the real objectives of an information system.

3) Identify Constraints

System constraints are also known as problem boundaries or restrictions. Knowledge of the constraints is essential, as it helps the designer to consider the limitations that restrict the design of the system.

System constraints may be classified under two categories

i) External Constraints- external constraints are external to the organization. For example constraints posed by customers, government, suppliers.

ii) Internal Constraints- Internal constraints are posed from within the organization.

4) Determine Information needs

For a good design of information system, it is very important to know the real information need of management in a clear way. Thus the information needs which can really help the management in discharging the functions are identified.

Users has to specify

- What they want out of an information system
- Items of information that are needed to achieve the predetermined objectives

5) Determine Information sources

Information need is the basis for the design of MIS, the source of the information requires to be determined in order to identify input data along with identification of its source, timing and format etc.

Sources of information is classified as

- **Internal and External Records:** The internal records may be in written form like files, inputs and outputs, correspondence, reports, documentation of the present or planned systems etc., whereas external sources may include trade publications, government statistics, etc.

- **Managers and Operating Personnel:** User-managers and operating personnel may be an important source for understanding input, output and data processing requirements of an information system. However, gathering data from this source involves interviewing the managers and operating personnel, which requires proper planning and skill.

Information Needs ↓ / Sources →	Production	Accounting	Purchasing	
Annual Requirements	X			
Unit Price		X		
Ordering Cost		X		
Carrying Cost		X		
Lead Time			X	
Consumption Rate	X			

Fig. 11.8 Information Needs/Information Sources Matrix

<u>6.Develop Various Designs</u>

- a system analyst should be able to conceptualize the overall structure of the information system; he or she is going to design.
- conceptual design gives us an overview or a sketch of the structure of the MIS. Thus, conceptual design is like a skeleton of the MIS, which guides and restricts the form of the detailed design.
- To be more concise, it may be said that if conceptual design is the skeleton, then detailed design is the flesh. At this stage, the conceptual design would define the main decision points, information flows, channels of information and roles of user-managers.
- Here the system analyst works out broad feasible alternative combinations of input, storage, processing, communication and output to generate various conceptual MIS designs.

More than one alternative conceptual designs are to be developed which are compared to select the optimum one, which

(i) Meets the requirements of the users/organization, and

(ii) is cost effective.

The following criterion may be adopted as a basis for evaluating the designs:

Economic Basis A preliminary cost-benefit analysis of each of the designs is made.

Performance Basis Each alternative is objectively evaluated for the anticipated performance with the objectives of the systems as previously developed.

Operational Basis For eachalternative, analysis is made to determine the strong and weak points in respect of quality of the databases, information, potential breakdown points, etc.

7) Documentation of the Conceptual Design

The final selected conceptual alternative is documented in specific terms. The documentation of the conceptual design involves:
(i) Overall system flow,
(ii) System inputs,
(iii) System outputs, and
(iv) Other documentations like activity sheet and system description, etc.

8) Report Preparation

Having documented the conceptual design, the next step is to get an approval of the management (user) so as to start the detailed design activity. Thus, a proposal giving the cost to be incurred and possible organisational changes is prepared for the management

DESIGN METHODS

There are a number of methods for designing information systems. Following is a brief description of some of the popular methods.

i. **Problem Partitioning**
- The method is based on the principle of 'divide and conquer'. In this method, instead of solving the entire problem at once, the problem is divided into small manageable parts (modules) that can be solved separately.
- This problem partitioning method aims at reducing complexity because each module can be developed, coded and tested relatively independently of the others. Also, maintenance is minimised if each module can be modified separately.

ii. **Structured Design**
- In this method, a structured chart is created, which can be used to implement the system. The chart depicts modules defining each module by the specific function.
- The aim is to produce a structure where the modules have minimum dependence on each other (decoupling); and have a high level of cohesion, meaning all the statements within a module are functionally related. Various tools like flow-charting, data flow diagrams, structure charts, structured English, etc., are used in a structured design.

iii. **Top-Down Design**
- The top-down design is based on the concept of a system which suggests that a system consists of sub-systems (components), which have sub-systems of their own.
- In other words, a system may be termed as a hierarchy of sub-systems, the highest level sub-system corresponding to the total system.
- Accordingly, this method involves the identification of the main components of the system decomposing them into their lower-level components and iterating until the desired level of detail reached.
- It attempts to smoothen the path of system design by starting at the top and designing the brot.1 modules first.
- At each stage, adequate attention is paid to subsequent interfacing so that as the system expands further, modules can be added without trouble.

DETAILED SYSTEM DESIGN
- Conceptual design in itself is not the end of the design process; rather it serves as a basis for the detailed MIS design.

- The performance requirements specified by the conceptual design become inputs to the detailed design phase, in which these are further refined, detailed and finalised to be called the system specifications.
- Thus, the main objective of the detailed system design is to prepare a blue print of a system that meets thegoals of the conceptual system design requirements.

Detailed system design involves the following phases.

(i) Project Planning and Control
(ii) involve the User
(iii) Define the Detailed Sub-Systems
(iv) Input/Output Design
(v) Feedback from the User
(vi) Database Design
(vii) Procedure Design
(viii)Design Documentation

(i) Project Planning and Control

Project Planning

(i) Formulate the project objectives.
(ii) Define the project tasks.
(iii) Prepare a network diagram of all events and activities so as to specify sequential and parallel events.
(iv) Schedule the work as per the requirements of the user.
(v) Prepare a budget for the project.

Project Control

(i) Get a feedback of the actual performance of the project with respect to time, cost and work of the project and compare it with schedules, budgets and technical plans.

(ii) Take corrective action where required so as to maintain control.

(ii)Involve the User

- System designers must inform the users regarding the new information system being developed and gain their support and acceptance.
- In this phase, users are assured that changes will benefit them or they will not be at disadvantage because of the new system.
- It is also important to take users in confidence so as to obtain information for the design of the system.
- This will also help managing resistance to change and would ensure successful implementation of the system.

(iii)Detailed Sub-System Definition

- In detailed system design, every system needs to be broken down to ascertain all activities required and their respective inputs and outputs.
- In some of the cases, sub-systems are broadly defined in the conceptual design phase, but at this stage they are specifically defined to work out every detail concerning the sub-system.

Decomposition of the system to operational activities in general is carried out as follows.

- System
- Sub-system
- Functional Component

- Task
- Sub-task
- Operation element

Wherever needed, integration of activities into a sub-system may be done on the basis of any one or more of the following common features.

(i) Common functions

(ii) Common techniques or procedures

(iii) Logical flow relationships

(iv) Common outputs or inputs

(iv) Output/Input Design

Output Design

The term output implies any information printed or displayed, produced by an MIS. At this stage, the following activities take place.

(i) Specific outputs which are required to meet the information needs are identified.

(ii) Methods for presenting information are selected, and

(iii) Reports, formats or other documents that act as carrier of information, produced by an MIS, are designed.

Objectives of output design:

(i) It should provide information about the past, present or future events.

(ii) It should signal important events, opportunities and problems.

(iii) It should trigger an action in response to some events.

(iv) It should confirm an action as a result of some transaction.

Main points of output design:

The following points are need to be answered for designing good output:

(i) Who will receive the output?

(ii) when and how often is the output needed?

(iii) what is its planned use?

(iv) How much details are needed?

Presentation of output:

The presentation may be either tabular or graphical or both.

Input Design

Objectives of Input Design

The main objectives which guide the input design are briefly discussed as below:

(i) Control the volume of input data: Try to reduce data requirements and avoid capturing unnecessary data. Constant and system-computable data should not be captured.

(ii) Avoid processing delays during data entry: Automating data capturing may reduce this delay. (iii) Avoid data entry errors: Checks in the data entry programs, which are called input validation techniques may help.

(iv) Keep the process simple: The system should be kept as simple and easy to use as possible.

Input Layout

The input layout should contain the following.

(1) Heading and date of data entry.

(ii) Data heading and value.

(iii) Data type and width of the column.

(iv) Initials of data entry operator.

ABC Pvt. Ltd.
Salary Statement for the Month N(2)

Total Pages N(2)				Print Date:
Emp. Code	*Name*	*Amount*	*Account No.*	*Remark*
X (4)	X (20)	N (8)	X (4)	X (25)

Figure 13.11 Output Layout

(v) Feedback from the User

This step will increase the acceptance of the MIS being designed.

The system analyst should demonstrate the proposed MIS to the users of the system sub-system. This step will also reassure the top management of the user organisation that the detailed design project is progressing as per plans.

(vi) Database Design

- A database is an orderly arrangement of all the records related to each other.
- It serves as a data resource for the MIS of an organization.
- To have optimum performance, storage and fast retrival of data, database design is an important phase in the detailed design of a system.

For designing a database, the designer should keep the following points in mind.

(1) Identify all data tables and record types.

(ii) Identify fields for each table, the key fields for each table and relations between various tables.

(iii) Determine the data type and width for each field of the tables.

(iv) Normalise the data tables.

(v) Properly document data dictionary.

(vii) Procedure Design

There is a wide variety ofprocedures, which include:

(i) Data Entry Procedures: These are the methods designed for data entry, e.g. data entry sequence. (ii) Run-time Procedures: The actions to be taken by the users to achieve the intended result, e.g. a procedure may instruct the user to load printer with a specific size of paper.

(iii) Error-handling Procedures: These procedures help the user in detecting and correcting ear

(iv) Security and Backup Procedures: Through these procedures information is provided regarding actions required to be taken to protect the system against damage.

(v) Software Documenting Procedures: The programmers get instructions on how to document the programs.

In designing procedures, designers should:

(a) understand the purpose and quality standard of each procedure

(b) develop a step-by-step direction for each procedure, and

(c) document all the procedures.

(viii) Design Documentation

Design documents should consist of comprehensive details of all the design phases.

Design documentation of detailed design report, generally, consists of

(i) System objectives,

(ii) Design constraints,
(iii) Inputs/outputs,
(iv) Data files,
(v) Procedures (manual),
(vi) Proposed system (a summary and detailed flow charts),
(vii) Input/output specifications,
(viii)Program specifications,
(ix) Database specifications,
(x) Cost of installation and implementation, and
(xi) System test conditions.
System development life cycle

SYSTEM DEVELOPMENT STAGES

To develop a system successfully, it is managed by breaking the total development system into smaller basic activities or phases.

1. Investigation
2. Analysis
3. Design
4. Construction
5. Implementation and
6. Maintenance

1. System Investigation

The user may invite system analyst to assist him in defining and resolving the problem.
Investigation is the first step in system development process. System investigation includes the following two sub stages:

- Problem definition and
- Feasibility study

Problem Definition:

Proper understanding and definition of the problem is essential to discover the cause of the problem.
Here are some possible definitions of problems.
(1) The existing system has a poor response time, i.e. it is slow.
(ii) It is unable to handle the workload.
(iii) The problem of cost, i.e. the existing system is not economical.
(iv) The problem of accuracy and reliability.
(v) The requisite information is not produced by the existing system.
(vi) The problem of security.

Similarly, a system analyst should provide a rough estimate of the cost involved for the system development.

Feasibility Study

The literal meaning of feasibility is viaility.
Feasibility study, basically, is a high-level capsule version of the entire process, intended to answer a number of questions like

- what is the problem?
- is the problem even worth solving?

However, as the name indicates in preliminary investigation, feasibility study should he relatively brief, as the objective at this stage is only to get an idea of the scope.

The aim of a feasibility study is to assess alternative systems and to propose the most feasible and desirable system for development.

The feasibility of a proposed system can be assessed in terms of four major categories:

Organisational Feasibility

- The extent to which a proposed information system supports the objective of the organisation strategic plan for information systems determines the organisational feasibility of the system project. The information system must be taken as a sub-set of the whole organisation.

Economic Feasibility

- in this study, costs and returns are evaluated to know whether returns justify the investment in the system project. The economic questions raised by analysts during the preliminary investigation are for the purpose of estimating the following:
- the cost of conducting a full system investigation.
- the cost of hardware and software for the class of application being considered.
- the benefits in the form of reduced costs, improved customer service, improved resource utilisation or fewer costly errors.

Technical Feasibility

- Whether reliable hardware and software, capable of meeting the needs of the proposed system can be acquired or developed by the organisaton in the required time is a major concern of the technical feasibility.

In other words, technical feasibility includes questions like:

a) Does the necessary technology exist to do what is suggested and can it be acquired?

b) Does the proposed equipment have the technical capacity to hold the data required to use the new system?

c) Will the proposed system provide adequate responses to inquiries, regardless of the number of locations and users?

(d) Can the system be expanded?

e) Is there any technical surety of accuracy, reliability, ease of access and data security?

Operational Feasibility

- The willingness and ability of the management, employees, customers, suppliers, etc., to operate, use and support a proposed system come under operational feasibility.

The following questions are asked in operational feasibility.

a) Is there sufficient support from the management? From employees? From customers? fromsuppliers?

(b) Are current business methods acceptable to the users?

c) Have the users been involved in the planning and development of the system project

<u>Methods of Preliminary Investigation</u>

During a preliminary investigation, the following two main methods are used.

i. Reviewing Documents, and
ii. Interviewing selected persons.

Reviewing Organisation Documents

- The analysts conducting the investigation first learn about the organisation involved in, or affected by, the system project.

- For example, to review an inventory systems proposal means knowing first how the inventory department operates and who the managers and supervisors are
- It can be learnt by examining the organisation charts and studying written operating procedures. The procedures describe how the inventory process should operate and identify the most important steps involved in receiving, managing and dispensing stock.

(ii) **Conducting Interviews**

- Written documents do not give user-views about current operations. To learn these details, analysts conduct interviews.
- Interviews allow analysts to learn more about the nature it the system project request and the reason for submitting it., interviews should provide details that further explain the proiect and show whether assistance is merited economically, operationally and technically.

The following format is suggestive of the preliminary investigation scope.

1. Project Title
2. Problem Statement : Concise, possibly in a few lines, stating the problem
3. Project- Objectives : State objectives of the project defined by the problem

4 Preliminary Ideas : Possible solutions, if any., occurring to user and /or analyt stated here

5.project scope: give overall cost estimate

6. Feasibility study: indicate here time and cost fro the next step.

2. <u>System Analysis:</u>

Analysis is a detailed study of the various operations of business activity (system), along with its boundaries,

The objective this phase is to determine exactly what must be done to solve the problem

System analysis involves a detailed study of:

- The information needs of the organisation and its end users.
- Existing information systems (their activities, resources and products).
- The expected information system

The final product of system analysis is a set of system requirements of a proposed information system.

3. **<u>System Design</u>**:

System analysis describes What a system should do to meet the information needs of users. System design specifies HOW the system will accomplish this objective.

System design should stress on the following three activities.

(i) User interface,

(ii) Data design, and

(iii) Process design.

- an interface design activity focuses on designing the interactions between end users and computer systems;
- the data design activity focuses on the design of the logical structure of database and files to be used by the proposed information system.

- Process design activity focuses on the design of the software resources, that is, the programs and procedures needed by the proposed information system.

4. **Construction and Testing**

- Once the system specifications are understood, the system is physically created.
- The required programs are coded, debugged, and documented.
- The system should be tested with some test data to ensure its accuracy and reliability.

5. **Implementation**

- The system implementation stage involves hardware and software acquisition, site preparation, user training and installation of the system.
- again, testing of the system involving all components and procedures should be done
- . Even a well-designed system will fail if it is not implemented.

6. **Maintenance**

- System maintenance involves the monitoring, evaluating and modifying of a system to make desirable or necessary improvements.
- Maintenance includes enhancements, modifications, any change from the original specifications. Therefore, the information analyst should take as his/her responsibility so as to keep the system functioning at an acceptable level.

SYSTEM DEVELOPMENT APPROACHES

System development consists various phases. In order to make sure that the systems are analyzed and designed efficiently and effectively, it is essential to adopt a suitable model, for which a basic understanding of various system development approaches is must.

The goal is to produce high quality software.

A system development model specifies how these activities are organised in the System development effort. Various models for system development are discussed below.

Waterfall Model

- This model follows the SDLC
- ' The model states that the phases are organised in a Linear Order
- The output of one phase becomes the input for the next phase
- The waterfall model is shown in Fig.

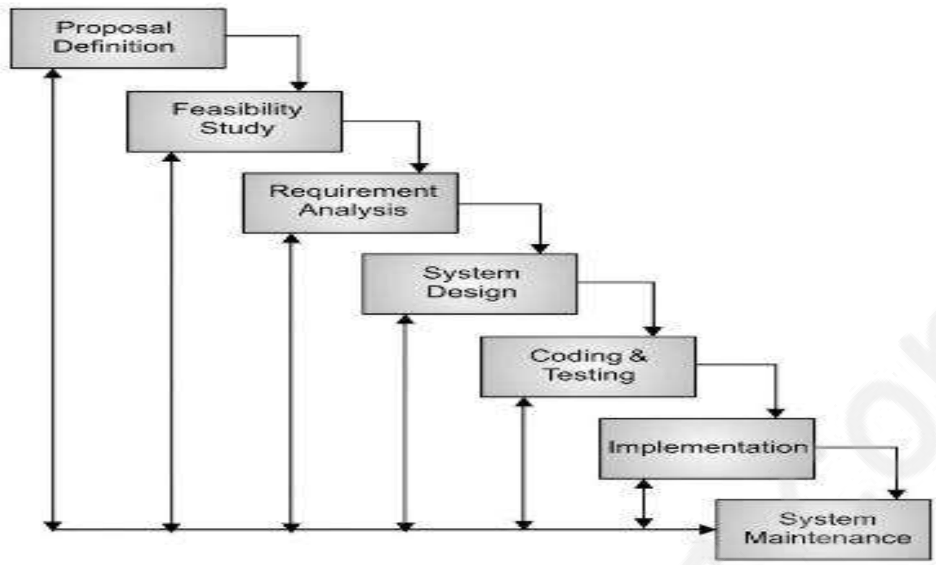


Figure 12.1 Waterfall Model

Advantages :

- The model is simple and easy to understand and use
- Each phase has specific deliverables
- Quality of the IS is ensured as each phase is well defined and distinct

Limitations of Waterfall Model

(i) In the waterfall model, every phase is considered as a distinct phase, which can be isolated from the rest or the next phase. To elaborate, the model assumes that the requirements of a system can be frozen before the design begins.

(ii) Freezing the requirements usually requires the choice of hardware to be made. However, in the case of large projects, which might take a few years to be completed, the earmarked hardware technology may become obsolete even before the system becomes physical.

(iii) The model stresses that the requirements should be completely specified before the beginning of the next phase. But in some of the situations, it might be desirable to first develop a part of the system completely and later enhance in phases

Prototyping

- In this approach, the system is developed, instead of the complete system.
- A prototype is a comprehensive system and does not include all requirements of the user.
- This model is based on the evolutionary method.
- It is used when identification of requirements is difficult and requirements may change during the development process. This model advocates the development of a throw-away prototype to be given to the user to help understand his/her requirements.
- On the basis of feedback, the actual system is developed.

The model has the following four steps.

(1) Identify the user's basic information requirements

In this step, the user identifies his requirements in the form of outputs required from the system. The information analyst, on the basis of user expectations, estimates the cost of a workable prototype.

(2) Develop the initial prototype

The system which meets the user's basic information requirements is developed. It is developed in the minimum possible time. The speed of building rather than efficiency of the prototype is the main consideration.

3) **Use of the prototype system to refine the user's requirements**

The initially-developed prototype is delivered to the user to allow him to gain hands-on experience with the system to identify further refinements/changes required in the prototype.

4) Revise and enhance the prototype system

- The designer .makes the necessary changes pointed out by the user after using the prototype.
- Steps 3 and 4 are repeated again and again till the prototype is refined to the satisfaction of the user.
- Prototyping approach may not be cost-effective in small organizations .it is suitable for larger organisations where it is difficult to identify user requirements.

advantages

- Ability to 'try out' ideas without incurring large costs.
- Lower overall development costs when requirements change frequently.
- The ability to get a functioning system into the hands of the user quickly.

Drawback:

- This approach requires at least two iterations
- it may become an unending process of refinement, which nay take too much time, effort and money.
- Second, it is also criticised because prototypes are usually not complete systems and many of the details are not built in the prototype.
- Third, due to frequent changes, management of the development process also becomes difficult.

System Development Approaches

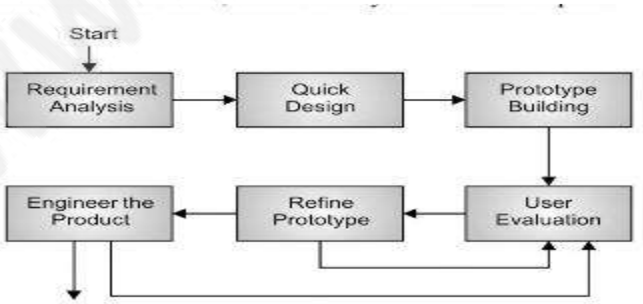


Figure 12.2 Prototype Model

Iterative Enhancement Model

- In an iterative enhancement model, the system is developed in increments and each increment adds some functional capabilities to the system, until the full system is developed
- Additions and modifications can be done at each step.
- The selected subset may be one of the important subsets, which may contain some of the key aspects of the problem.
- The iterative enhancement process model is understood to have only three phases, namely, analysis, implementation and design, Design. Implement. Analysis.

- This model has an advantage that it can result in better testing, as testing each increment is relatively easier than testing the entire system, as in the waterfall model.
- Also, as in prototyping, the increments provide feedback to the user which is useful for determining the final requirements of the system.
- Thus, iterative enhancement model combines the benefits of both prototyping and the waterfall model.
- Iterative enhancement model also suffers from the following limitations. ,
    - The model does not give a complete system and thus many of the details may not be incorporated in the developed system.
    - As the model is based on 'modify-it-again' approach, it may be time-consuming and is not cost-effective

Fig. 10.3 The Iterative Enhancement Model

Spiral Model

- The spiral model is the most recent system development model.
- This model suggests that the various activities involved in system development should be organized like a spiral.
- This model provides a framework for developing a process, which is guided by the risk level of the project.
- This model is cyclic in nature .Each cycle of the spiral consists of four stages represented by one quadrant each.
- The angular dimension represents the progress in the development process, whereas the radius of the spiral represents the cost involved.

- The first stage is concerned with the identification of the objectives, various developmental alternatives and constrains to develop an information system.

- Evaluation of various alternatives and identification of the risk is undertaken in the second stage.
- In the third stage, next level prototype is developed and verified and the results of the previous stages are reviewed and planning for next iteration is done in the fourth stage.
- The spiral model is more suitable for high-risk projects. For small projects, this model may not be time- and cost-effective.

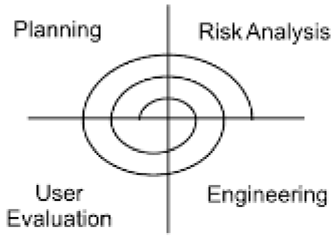


Figure 12.4 Spiral Model

4GT

Another technique, known as the Fourth Generation Technique (4GT), is also being used to quickly develop information systems.

- This technique makes use of a number of software development tools.
- The developer has only to specify a few characteristics of the software at a high level. The tools then automatically develop the code for the given specifications.
- This model is quick but its success is restricted by the capacity of the available 4GLs..

End user Development – Managing End Users

End-user development refers to the development of information systems by end users with minimal or no assistance from professional systems analysts or programmers. This is accomplished through sophisticated user-friendly software tools and gives end users direct control over their own computing.

Policies and procedures to manage end-user development include the following:

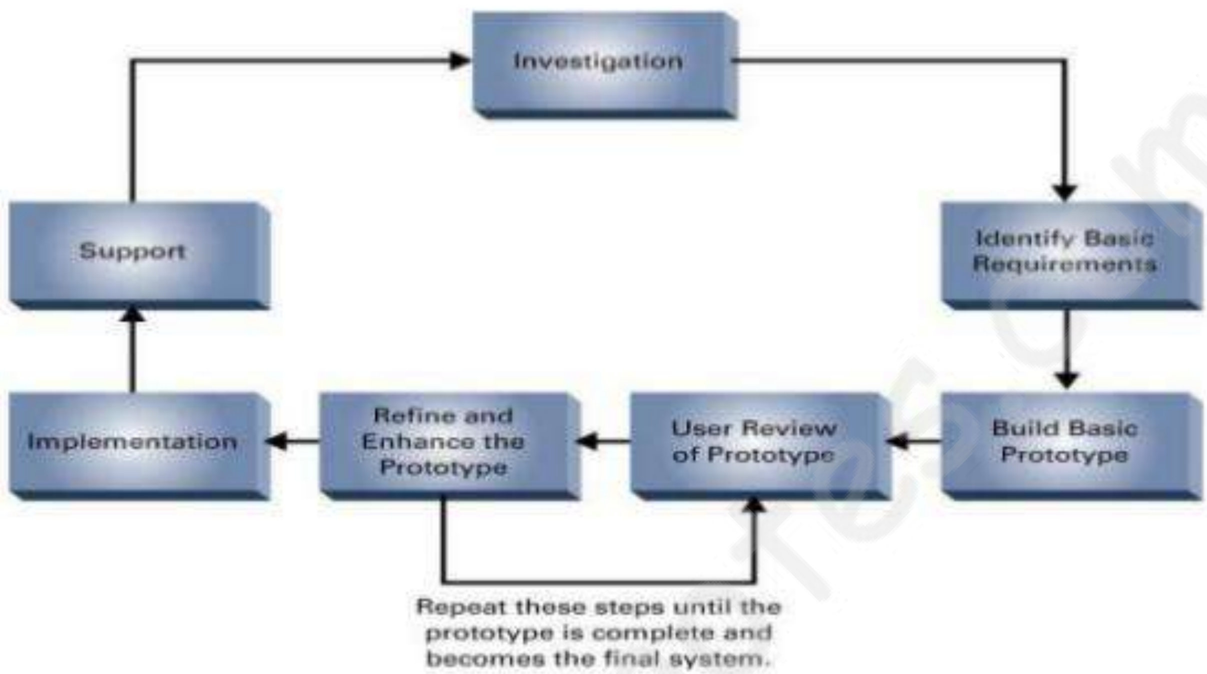
- The organization must establish sufficient support facilities for end-user computing: information centers or distributed end-user computing centers.
- Training and support should be targeted to the specific needs of those being trained.
- End-user application development should not be allowed to be undertaken randomly but should be incorporated into the organizations strategic plan.

Management should develop controls over end-user computing in the following areas:

- Cost justification of end-user information system project
- Hardware and software standards for user-developed applications
- Company-wide standards for microcomputers, word processing software, database management systems, graphics software, and query and reporting tools
- Quality assurance reviews that specify whether the end-user systems must be reviewed by information systems and internal audit specialists
- Control for end-user developed applications covering testing, documentation, accuracy, and completeness of input and update, backup, recovery, and supervision

- Critical applications that supply data to other important systems should be flagged and subjected to more rigorous standardsDescribe the advantages and disadvantages of developing information systems based onapplication software packages.

End user development life cycle.



Cost-benefit modeling

This study defines costs as the sum of:

- Technical cost: the price of the technology and the effort to install it
- Learning cost: the time taken to understand the technology
- Development cost: the effort to develop applications using the technology
- Test and debugging cost: the time taken to verify the system

The first and second costs are incurred once during acquisition, whereas the third and fourth are incurred every time an application is developed. Benefits (which may be perceived or actual) are seen as:

- Functionality delivered by the technology
- Flexibility to respond to new requirements
- Usability of applications produced
- Overall quality of the applications produced

Examples of end-user development include the creation and modification of:

- Animation scripts used by graphic artists to describe characters, environments and how characters move to produce an intended animation
- Game modifications to introduce users' own characters, environments, etc. — many recent games are distributed with modification in mind
- Mobile app development tools such as App Inventor
- Process models used in workflow applications
- Scientific models used in computer simulation

- Scripts and macros added to extend or automate office productivity suites and graphics applications.
- Spreadsheet models, e.g., used for budgeting, risk analysis, interactive machine learning,[20] or electronic circuit design[21]
- Web pages - plain HTML or HTML and scripting
- 3D models created with end-user oriented tools and apps such as Sketchup

Advantages of End User Development

- Encourages active user participation
- Improves requirements determination
- Strengthens user sense of ownership
- Increases speed of systems development

Disadvantages of End User Development

- Inadequate expertise leads to underdeveloped systems
- Lack of organizational focus creates "privatized" system
- Insufficient analysis and design leads to subpar systems
- Lack of documentation of a system may lead to its being short lived

off– the shelf software packages

WHAT IS BESPOKE SOFTWARE?

Bespoke software – sometimes called custom software or tailored software – is a software solution created for a specific user. It is made entirely to their specifications and tailored to their precise needs. A bespoke software solution will meet all of your business requirements and even be developed to fit into your current ways of working. As the solution is tailored to a business's individual needs, it can be integrated with other bespoke or packaged software, replace a legacy system, and can be updated and expanded in the future.

Bespoke software is seen as the alternative to commercial software or "off-the-shelf" software.

WHAT IS OFF-THE-SHELF SOFTWARE?

In general, it is pre-packaged software with a general purpose that works with different business models. This pre-packaged "Off-the-shelf" software is not tailored and intended for use by the mass market. This means that you can buy it but may never use all of the features available. You might not even be able to use the pre-packaged software to carry out all of the tasks you would like to. In which case, you will have to adapt your ways of working around the software or purchase another solution to fill the gaps.

The Bespoke Software Solution Development Cycle

A Bespoke Software Solution is purpose built to meet a specific need.

In order to ensure that the bespoke system is fit for purpose, it is imperative that sufficient planning is done from the outset and throughout the development and post development stages of the project.

Analysis

One of the most important parts of developing a bespoke software solution is the planning. We will start with an initial consultation to broadly establish your requirements, how your business works and if indeed a bespoke software solution is the answer.

Following our initial consultation we will go away and put together a proposal, outlining the proposed solution including the structure, timescales and costs. Providing all parties are in agreement with the proposal we will proceed to the next step.

Design

The design phase is a critical part of the development process, it is not just about how the end product will look, but more importantly the ins and outs of what the system needs to do. We will spend time with you going through your existing processes in detail and document the proposed solution, identifying the required functionality, processes and rules which need to be implemented into your new system.

Coding

This is the process of actually building and coding your software solution by our developers. Once the system has gone through internal testing, a version of the software will be given to you, the client, for User Acceptance Testing (UAT). This is your opportunity to identify any issues or make any final adjustments.

Deployment

Once you are satisfied that your new system is fit for purpose, we will deploy the system, either physically or virtually depending on the chosen platform. We can work with you to help train you and your end users where applicable.

Support

Once the system has been released and signed-off we enter a support phase where we can arrange an ongoing maintenance and support contract or ad hoc support to your new system.

Advantages

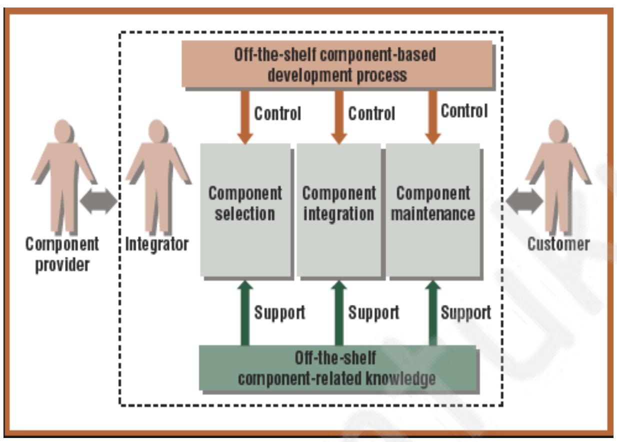
Bespoke solutions are custom built to suit your business' specific needs and requirements, which gives you the opportunity to configure the software around your existing processes, which is a more flexible approach than off the shelf systems provide. For some companies, bespoke software solutions are the only option, if what you do or what you need your system to do is so unique that you wouldn't find an off the shelf package that would accommodate your needs. Bespoke development can also provide your organisation with a competitive advantage as your business can work in a different way to other companies in your sector or industry.

- You determine how your system will work.
- Flexible approach compared to off the shelf systems.
- Potentially provides a competitive advantage.

Disadvantages

- High initial purchase cost.
- Lengthy development timeframes.
- No online community support for users.
- High-risk solution.

Off the shelf software is generally packaged software that is sold 'off the shelf' for users needing common applications as opposed to custom software which would be designed for a specific purpose and would be unique for that particular users needs.
Off the shelf software would include packaged software as Photoshop, Microsoft office, Pastel accounting etc which one could purchase and install.



Advantages
Off the shelf software tends to be a cheaper than bespoke development at the initial purchase stage, which tends to be the reason why so many companies choose pre-configured systems. They are often available to implement straight away, so you can have your team or department using the system within days or weeks. Also, off the shelf software packages are used by other businesses and users, so there is usually a variety of guides including books, tutorials, best practices and other resources available online to turn to for support. Vendors who supply off the shelf software also tend to provide regular upgrades so that you will have an up to date system.

- Initially cheaper than bespoke development.
- Quick implementation, most systems are ready to use straight away.
- Online guides and forums to support your users.
- Regular upgrades are available.

Disadvantages
However, it's important to realise that it's unlikely you will find a pre-configured solution that has all of the features and functionality your business needs, in the way that you need and

changing the system is usually impossible or very expensive. As most off the shelf packages are made to cater to a broad audience, they often include lots of functions that you will not use or need, but will have to pay for anyway. Although most systems will come with regular upgrades, you might have to pay for these updates and not gain anything by doing so as the new features are not suited to your business. Support from software vendor will usually come at a cost, and some providers may stop your support if you refuse to upgrade your system to the latest version. One of the most important things to consider is that your business will have to work with the software, rather than the software being configured to suit the way your business works/operates.

- Expensive or impossible to change.
- Unnecessary features and functionality.
- Upgrade and support costs.
- Limits your control on how your business operates.

What Is Outsourcing?

Outsourcing is the process of engaging a third party individual or organization outside of your company, either locally or internationally, to handle certain business activities for you. It is a common business practice that allows companies of all sizes to grow as and when they need it, without major risk or investment.

Knowledge Process Outsourcing (KPO)

Knowledge Process Outsourcing (KPO) means information related business task or knowledge-based processes such as research, analysis, consultancy or any other high-level task are outsourced i.e. done by the workers of another company or allocated to the subsidiary of the same organization.

Cost-effectiveness, access to the best talent, focus, better utilization of the resources are the advantages of Knowledge Process Outsourcing (KPO).

Some famous companies providing such KPO services in India are Wipro, TCS, WNS Global, Aditya Birla Minacs etc

Business Process Outsourcing (BPO)

Business Process Outsourcing, popularly known as BPO, is the business strategy where one company hires another company to perform a certain task for them, i.e. they outsource a certain job.

Forms of Outsourcing

1. Offshore outsourcing: When the work is contracted to a company that does not reside in the same country. India and China have emerged as popular destinations for offshore outsourcing.

2. Near-shore outsourcing: When the work is contracted to a company that resides in the neighbouring country.
3. Onshore outsourcing: When the work is contracted to a company that is in the same country.

Functions of Business Process Outsourcing (BPO)

BPO can offer lot of services to the customer. Following is a list of services BPO offers in general:
1. Telemarketing 2.Customer Helpdesk 3. Support Services 4. Lead and Sales Generation
5. Back Office Operations 6. Document Processing 7. Data Entry 8. Verification Services

Advantages of Business Process Outsourcing (BPO)

1. Focus on Core Competency. 2. Reduction in Costs. 3. Increase in efficiency of business process.
4. More Employment generation. 5. Focused teams solving problems.

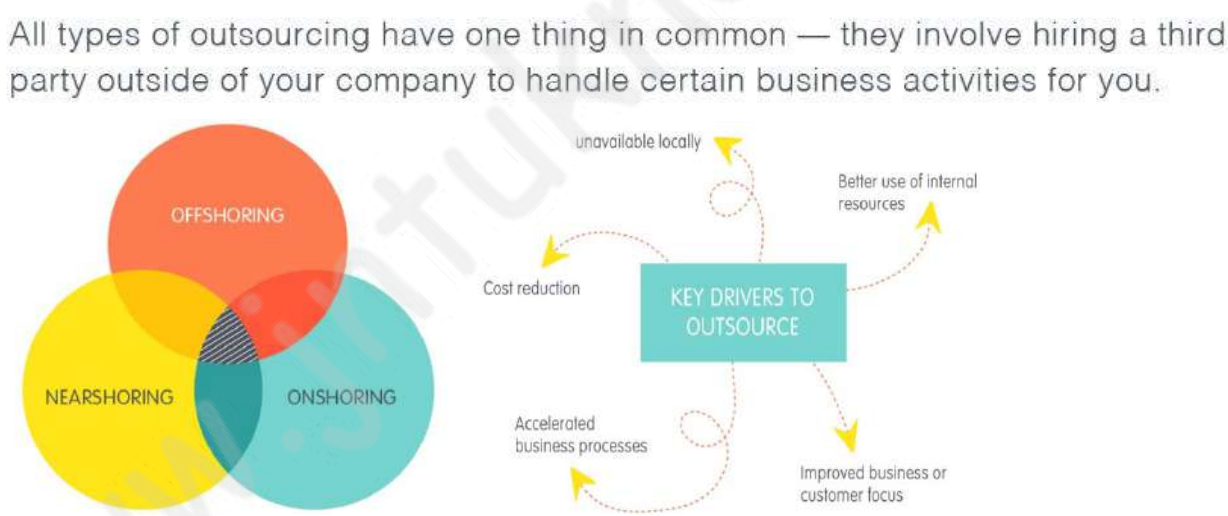
Disdvantages of Business Process Outsourcing (BPO)

1. Overdependence on third party vendors.
2. Lack of complete knowledge of product/service offering leading to customer dissatisfaction.
3. Less focus on quality because of lower cost offerings through outsourcing.

Second example can be outsourced delivery services to e-commerce websites. There are many companies who provide delivery staff, pick up and drop, reverse supply chain management services to e-commerce websites.

IT outsourcing

IT outsourcing involves sub-contracting or "farming out" certain information technology functions to independent, third-party companies or individuals, instead of keeping those functions in-house.



Types of IT Outsourcing

There are several types of IT outsourcing, defined by where the outsourced work happens. These include:

- **Moving business/services overseas**, typically to take advantage of lower costs and/or a more favorable economic climate.
- **Nearshoring**: transferring business or services to another country close by, oftentimes sharing a border with your own country.

- **Homeshoring/onshoring**: allowing employees to work from home rather than an office, factory, or related physical workplace.

Reasons for outsourcing

- **To reduce cost.** More often than not, outsourcing means saving money. This is often due to lower labor costs, cheaper infrastructure, or an advantageous tax system in the outsourcing location.
- **To access skills that are unavailable locally.** Resources that are scarce at home can sometimes be found in abundance elsewhere, meaning you can easily reach them through outsourcing.
- **To better use internal resources.** By delegating some of your business processes to a third party, you'll give your in-house employees the opportunity to focus on more meaningful tasks.
- **To accelerate business processes.** When you stop wasting time on mundane, time-consuming processes, you'll be able to move forward with your core offering a lot faster.
-

Examples of Frequently Outsourced IT Services

- Application/software development
- Web development/hosting
- Application support or management
- Technical support/help desk
- Database development/management
- Telecommunications
- Infrastructure

Advantages of Outsourcing

There has to be a good explanation for why so many places are doing it, right? Here are some of the reasons that companies and entrepreneurs are choosing to outsource parts of their business.

- **Expertise**: sometimes an overseas vendor/business has special equipment and/or technical expertise, making them better at the given task than employees within the outsourcing organization.
- **Reduced costs**: a big draw to outsourcing work overseas is reduced costs for labor, operations, and even equipment.
- **Staffing flexibility**: according to James Bucki, "Outsourcing will allow operations that have seasonal or cyclical demands to bring in additional resources when you need them and release them when you're done."

Disadvantages of Outsourcing

Here are some potential disadvantages to outsourcing.

- **Language/cultural barriers**: these can affect both employees and customers, especially when clear explanations of the problems and solutions are required.
- **Different time zones**: this can add as a barrier to communication and coordination with the hiring company.
- **Slower turnarounds**: the language barriers coupled with time differences can sometimes lead to longer project/resolution times.
- **Possible loss of quality**, unless you invest time in a rigorous screening process.

Comparison of different methodologies.
Insourcing

Insourcing assigns a project to a person or department within the company instead of hiring an outside person or company. It utilizes developed resources within the organization to perform tasks or to achieve a goal. For example, an organization might insource technical support for a new product because the company already has existing technical support for another product within the organization.
Further, insourcing generally places new operations and processes on-site within the organization. For that reason, insourcing can be more expensive for a company because it often involves the implementation of new processes to start a different division within the organization.

Table 1. Feature comparison of In-house & outsource software projects

Features	In-house development	Outsource development
Resources	Limited and defined.	Supplementary resources because of specialty in such projects.
Technology	Limited range of technology with respect to specific projects.	Have more technology and tools for the project because company has specialized in that sort of projects.
Cost	More cost to hire domain and technology experts.	Less cost because of availability of experts and geographical cost difference.
Expertise	Narrow Range.	Wider range.
Speed	Slow and gradual.	Fast and progressive.
Quality	Less Quality variation.	Quality variation more[20].
Flexibility	Rigid & less flexible because of local control and strict environment.	More flexible because of having more expertise in the current project[21].
Legal compliance	Less legal compliances because of domestic market and local laws.	More legal compliances because of geographical variations in laws and regulations.

5.3 In-House software projects challenges addressed by Outsourcing

In-house challenges	Outsourcing Solutions
Hidden and unpredictable expenses Bundle of unexpected costs have to bear such as purchasing new hardware for specific project, maintenance, management and up gradation costs[11].	**Expected and predictable expenses** Can save thousands as less maintenance, up gradation and management cost are required.
Staffing and Training In case of specialized and complex projects home organization doesn't have enough expertise and workers available so have to conduct project based hiring and training[22].	**No Project based Hiring and Training required** Specialized outsourcing organizations have already experts available so don't have to do hiring. Hence can quickly fly the project towards completion.
Maintenance overhead Maintenance of projects is highly complex task and generally required a lot of times and cost to be done in house. Again have to hire experts for the maintenance.	**Better and World class Services** As the outsourcing organization is specialized in that sort of projects so require less time and cost to do maintenance.
Lack of up-to-date Technology and Tools In case of specialized and complex projects generally home organizations don't have enough technology and Tools available[23].	**up-to-date Technology and Tools** Best and latest tools and technology available are available to specialized outsourced organizations.
Capital Expense May occur due to purchase of new hardware and software.	**No Special Capital Expense** Hardware and software is already available to specialized outsourcing organization.
Retention and Training required Expert workers turnover rate is generally high so have to hire new employees and train them[12].	**No Retention and Training required** Skilled IT Experts available to accomplish the projects because of very less retention rate[24].