MANAGEMENT INFORMATION SYSTEM

BY

TANUJIT CHAKRABORTY

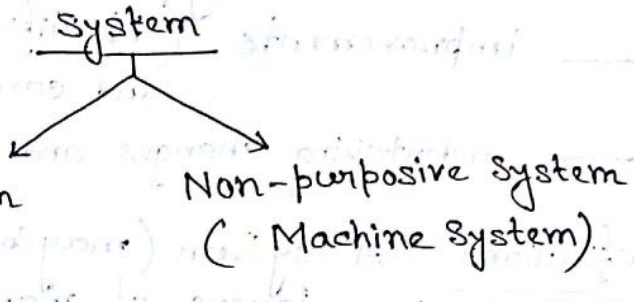
Indian Statistical Institute

Mail : tanujitisi@gmail.com

Management Information System

System:- A set of connected components often individual parts may not be added together to form the entire system.

Purposive System:- When a system as a whole has certain goals to meet.



Two approaches to problems: Synthesis and Analysis.

Absolve :- Expect that the problem will take care of itself in the long run (do nothing).

Resolve :- Solve the specific problem, long term solution is not provided.

Solve :- Provide a general solution by looking at the different parts of the system (Analysis perspective).

Dissolve :- Change the environment in a manner such that the problem vanish (or, at least its impact reduces).

Customer
- (System): Anyone impacted by the system
- (Information system): Anyone who uses information related to the system for its smooth operation and/or improvements.

Information:- A compilation of individual observations that enable customer of information system to initiate action.

Note:- (i) Operational Data:- Captured by most organisations in databases.

(ii) Improvement Data:- Scattered around databases. Data warehouses are used to put data of different types into one structured repositary.

Management:- A group within an organisation, responsible for
- routine planning and operation
- improvements (identification of opportunities and carrying out the same).
- undertaking changes and making investments accordingly.

MIS Definition:- A system (may be supported by software) that enables various layers of management to initiate action on the bases of compiled data. Apart from initiating action, MIS is also used for purpose of comparison and goal setting.

Layers of Management:- The perspective changes from planning and investing for the future (for the top management) to planning and ensuring smooth operations (for the middle and lower management).

Information Requirements:- Divided into three main layers:-

(1) Top Management:- Focuses more on external factors compares with others (global) players. Attempts to identify changes in technology / competition profile looks at longterm targets.

(2) Middle Management:- Acts as a bridge between top and lower level of management. Needs to achieve the following: (i) communicate (translate) the top level goals to the lower level; (ii) communicate (translate) the lower level acheivements to top level (typically trends/ summary measures); (iii) Understanding operation for identified of opportunities for improvements (investment requirements).

(3) Lower level Management:- Primarily operational works. The efficiency of the operations need to be captured and reported.

Operational Information System:- Information systems that capture & report on specific operations, usually the operations specified in the value chain.

Example:- An institution has admission & teaching systems. The admission systems keeps track of interviews & admission test marks where as teaching system keeps track of marks obtained in exams.

Note:- An information system that ensists of a number of operational systems with little interconnection is unlikely to provide guidelines regarding improvement.

- Need for Information:- Need for information in a management system can be extrapolated reviewing:

(a) The fundamental task or the organizational goals of the management;
(b) The fundamental functions of the management seeking the objectives to fulfil & implement the tasks;
(c) Deciphering the role of the flow of information of a management process.

Management Process Steps	Information Needs
Recognition of a problem.	(a) Performance against plan (b) Information concerning problems & opportunities
Define problem or opportunity	Evaluation of (a), (b) in upper step to define a problem
Decision	Prediction of results for alternatives
Implementation of a plan	Establish control standards & communicate detail of plan
Control performance against plan	Performance against plan with established controls.

Assessing information requirement :-

- Internally
- Externally

} carried out using the SWOT analysis

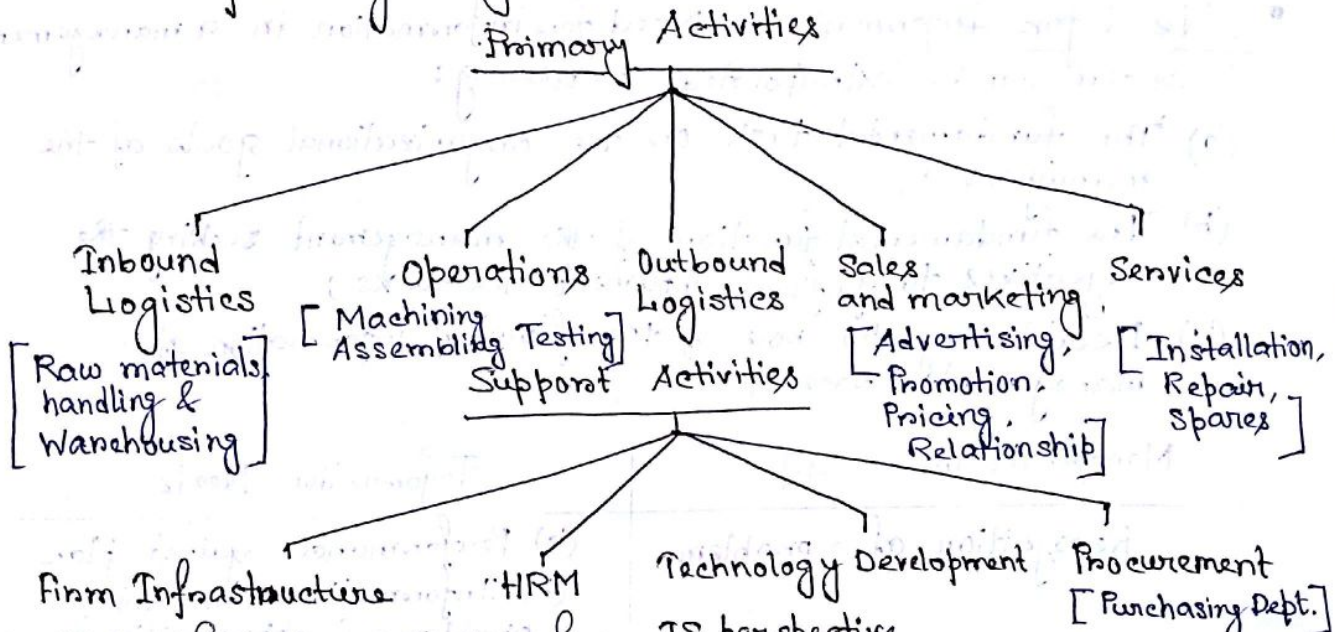
SWOT : Strength + Weakness + Opportunities + Threat

Strength + Weakness → Internal

Opportunities + Threat → External

Value chain analysis :- All activities carried out by a 'for profit' organisation has costs. In order to survive the organisation should be able to sell the services at a price higher than the cost.

A manufacturing organisation follows 'Long-Linked Technology'.



Usage of Value chain from IS perspective

- Examine the individual activities for
  - Routine Operations (consists of 3 Steps)
  - Efficiency (specific measures need to be developed)

Routine Operations

- Describe the operation → Requires specific rules.
- Identify the data required (generated)
- Design a system for storage and retrieval.

Outbound Logistics :- Warehousing & distribution of finished products.

Usage of value chain from IS perspective: —

— Improvement → Efficiency for individual value chain activities (What could be some efficiency measure?)
Efficiency:- ratio of input & output
→ Linkage between activities of value chain.

Linkage between activities :- Operational efficiency (ability to carry out the major activities impacting customers at lower level of input/ cost or higher level of quality or both) is impacted to a great extent by the linkages.

Forces impacting an organization: Five forces were identified:

- Buyer Power
- Supplier Power

(Market condition)

- Threat of new entry
- Threat of substitution

- Level of competition (general competitive environment)

Sixth force (Andy Groves) :- Complementarities. (The state or characteristic of being complementary)

Description of an activity (operation) :-

Use cases: Description of specific activities carried out by a (sub) system. It provides a pictorial description (supported by language) of the system and facilitates ensuring completeness.

Ensuring Completeness: Use cases identify all actors that interact with the system.
↳ generally the completeness of actors is easier to check

Two prospectives of an information system
- Structural
- Behavioural

Describes how the system function
- Use case
  External functional view of the system (stated requirement of the system)
- State Machine
- Activity Diagram

How the different data are maintained with the system.

[Non-functional view:- Describes the efficiency of environment of the system]

- Use case format :- ... (Issuing a book from a library)

Primary Actor :- One who uses the system for a specific purpose. (Borrower)

Other actors :- Those who use / get impacted by this transaction. (Issuer, Book Database system).

Scope & Purpose :- Goal of the interaction. (Taking one or more books on loan from the library)

Preconditions :- Conditions that must hold true for the transaction to take place. (The borrower must be a valid member)

Post condition :- The state of the system after the use case has been executed. (The status of the library & borrower data base must change).

Main Scenario :- Step-by-step description of the most frequent (attempted) scenario. (Find the number of book the borrower can borrow, book type, return date)

Data to be captured :- All data that need to be captured w.r.t. precondition and the scenarios with definition and objective.

Stage	Data to be captured	Definition	Objectives
Precondition	Validity of membership of the borrower	Binary Data	Assess whether a large % are invalid borrowers

State diagrams (State transition diagrams) :- A system goes through a number of states. The states get changed as the system in a particular state receives an input.

Starting state :- Alive, not in use

State Transaction Table

	Inputs (signals to the system) I_1 I_2 .....
$S_{Initial}$	
S_1	
S_2	
⋮	
S_m	
S_{End}	

Management Information System:- MIS is also known as Information System, Decision system.

- The MIS is defined as an integrated system of man and machine for providing the information to support the operations, the management and decision making function in the organisation.
- The MIS is defined as a system which provides information support for decision making in the organisation.

The meaning of different terms in MIS:-

Management:- Management is a body which comprises processes or activities (planning, organizing, controlling & initiating operations) of an organization for its smooth functioning & attainment of its predetermined goals through optimal utilization of its resources (men, money, material, machine).

Information:- Data are facts & figures which can take the form of historical records pertaining to the operations of the enterprise. These can be filled appropriately & act as a source of the fixed documents, accounting ledgers, stock register & so on.. These can be processed to derive the information paramount importance to an organisation.

System:- A system is a set of elements in the form of ideas, things & people which are inter-related & part of cohesive set up, that synergise to achieve specific goal(s).

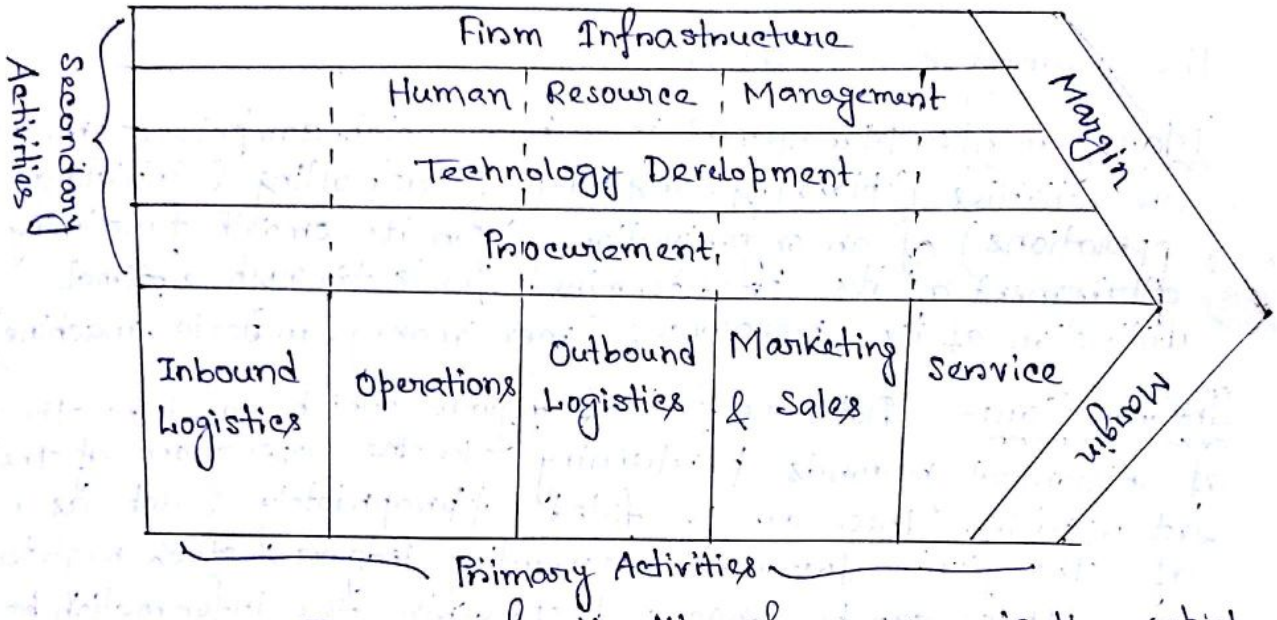
VALUE CHAIN ANALYSIS:- (Porter's Value chain Model, 2004)

Ques:- How the concepts of value chain and the different forces of competition helps us in developing a management information system.

Ans:- Every organization wants to earn profit, so they are in a process of profit making profession, therefore in order to achieve that they need to make avail of the products at the price higher than what they have invested. So to see overall investment, they need to keep records of all the things which they procure, i.e., they need to draw a basic chart (value chain chart) which would visualize the basic functions of the organization.

Since value chain consists two main activities which is categorized as Primary activity and Secondary Activity.

Under primary activities come inbound logistics, operations, outbound logistics, marketing & sales and services. The secondary activities consist of Firm Infrastructure, Human Resources Management, Technology Development and Procurement. Here is the value chain diagram:



These are functionality of any organization which can be started by any new organization but actually makes any organization more preferred comparing to others depend upon the quality of the products & services.

Next the organization see the market to identify the buyer's demand and also the competition from other organization, i.e., they have a threat of new entry which finally make them to have a threat of substitution. There are five competitive forces:

(1) Buyers power
(2) Supplier power
(3) Threat of new entry
(4) Threat of substitution
(5) Level of competition

The only way for any organization to solve this is to keep records of all these levels of impacting forces. This can be done only if they have a well-organized

management information system. so that according to changes occured due to impact of five forces that would be able to change their mode of approach. This will only happen if they have made a strong & efficient MIS. So, we can see that value chain & different forces work simultaneously. This is because of the impact of 5 competitive forces, the organization will be able to make changes in the value chain accordingly. Also we may call MIS as the interface between value chain & competitive forces. So the better the MIS is, the better is the productivity of any organization.

- Define Inbound, Operational & Outbound Logistics for Indian Oil Corporation. Construct a value chain for IOC.

Solution:-

Inbound Logistics:- Inbound logistics in a refinery involves locating crude oil supplier, making the contract, and arranging shipment from supplier to the purchasers, facility management in the uploading port, and transporting from unloading port to refinery and storage at refinery.

Operational Logistics:- Refining operations in a refinery is termed as operations. Main functions involved in operations are the control of delivery of crude oil from storage tanks to initial distillation columns, storage of distillates or streams in tanks, treatment of streams for converting into products, selection of processes for getting products, and blending operations.

Outbound Logistics:- Outbound logistics involves the movement of refined products from refinery to customer. IOC is doing their own refining and marketing. For transportation IOC is using pipeline, ship, rail or road.

Value Chain Model for Indian Oil Corporation

Inbound logistics for IOC:- IOC is in excellent position to offer O & M services for latest technologies such as distillate FCCUs, Resid FCCUs, hydrocrackers, reformers, lube processing units, catalytic de-waxing units, coke calciners, hydro-treaters for Kero and gasoil streams, etc. Indian Oil also offers the specified services of its experts for start-up assistance depending on the client's need. Its team is also well-equipped to prepare operation manuals with clear instructions for plant start-up, operation, shutdown, emergency handling, etc.

Operation Logistics for IOC:- (i) Cross country crude and multi-product pipelines, (ii) Mainline engines, pumps and motors,
(iii) Station facilities, crude oil and petroleum product tanks,
(iv) Automation advanced control systems,
(v) Single point Mooring (SPM) systems, submarine pipelines,
(vi) Development of maintenance procedures, formats, schedules,
(vii) Technical audits for better performance of energy consumption, quality, safety and environment protection
(viii) Onsite & offsite disaster management plans
(ix) Selection, testing and evaluation of Chemical Drag Reducers and corrosion inhibitors.

Outbound Logistics for IOC:- Indian oil, the pioneer in cross-country petroleum product pipeline in the Indian sub-continent constructed and commissioned its first petroleum product pipeline. Since last four decades the pipeline network of Indian oil has grown to 11,214 km.

Marketing & Sales of IOC:— Indian Oil provides a wide range of marketing services and consultancy in fuel handling, distribution, storage and fuel/lube technical services. Indian Oil is fully equipped to handle small to large-scale infrastructural projects in the petroleum downstream sector anywhere in the country. Indian Oil's fuel management system to bulk customers offer customized solutions that deliver least cost supplies keeping in mind usage patterns and inventory levels. Indian Oil's supply and chain distribution network is strategically located across the country linked through a customized supply chain system backed by front offices located in conceivably every single town of consequence.

The wide network of services offered by Indian Oil Sales & Marketing Division includes: Commercial LPG; Total fuel management; Indian Oil Aviation Service; LPG Business (non-fuel alliances); loyalty program; retail business (non-fuel alliances); SERVO technical services.

Services of IOC (Technology, Licensing & Training):-

Over the past four decades, Indian Oil R&D Centre has developed over thousands of formulation of lubricating oil and grases responding to the needs of Indian industry.

The India Oil Institute of Petroleum management — a centre of excellence for nurturing future leadership., situated on the outskirts of New Delhi, conduct some management educational programmes in collaboration with top B-schools.

Indial Oil operates 18 training centres across the India country for up-skilling, re-skilling and multi-skilling of employees in its pursuit of corporate excellence.

SWOT ANALYSIS OF MIS SYSTEMS:

Introduction: MIS is a great tool for companies & organizations to track the various activities happening in the organization. These activities can include the product produced, bought or sold; services, inventory, business partners, people, processes and a lot more. The MIS helps the manager to create reports about and for the various resources and stakeholders of the organization. MIS keeps company's information organised which can be utilized when required.

Strengths:-

1. A complete MIS solution can give a comprehensive picture of the company's performance at a point of time.
2. A secure MIS solution can be very transparent and can help organisations to keep a check on any malpractices happening in the organization.
3. The flow of informations among the various departments of the organization becomes lucid, smooth & accurate.
4. MIS helps in maintaining the three pillars of security in any organization. If used properly it can help the organisation in keeping the confidentiality, integrity & availability of the data.
5. MIS improves the problem solving capacity of the organization

Weaknesses:-

1. MIS is totally based on transactions. If transactions are not captured properly, the resulting organisation would also be faulty.
2. With the amount of data growing, MIS would require a lot of processing power to produce the expected results on time.
3. MIS is highly sensitive to changes. A small gap in the change may lead to drastic & devastating results.

Opportunities :-

1. The decision supported with flawless information combined with the coisdom of directors of the company can lead to unforseen opportunities. One of the basic decisions of investment can be made through the information given by the MIS.
2. A system in the manufacturing firm can control the flow of materials. This can reduce the cost of inventory. The concept of just-in-time can only be implemented if it is backed by a flawless MIS.
3. Marketing and sales department can be more accurate in their demand forecasting if a good MIS system is available to them.
4. Human resource MIS manages employees and selection of employees. Human Resource MIS looks at needs of the employees, the coorkforce rules, hiring processes, training & job assignments.

Threats:-

1. MIS is nothing without the human coisdom. If these systems or informations about the system falls into corrong hands, it can be misused. This is one of the biggest threats of MIS.
2. Natural threats can turn out to be devastrating if no back up in the systems is taken.
3. The designing of the MIS can also turn out to be a threat of the design is not flexible enough to accept change requests.
4. The transaction capturing system should be very accurate on capturing the data. Any violation in any of the rules in the captured data could percolate to the upper layer.

- Characteristics of MIS:-
  - Management Oriented : The system is designed from the top to downwards.
  - Management Directed : Management orientation of MIS, it is necessary that management should continuously make reviews.
  - Integrated : system has to cover all the functional areas of an organisation with a view to achieve the objectives.
  - Common data flow : common data flow avoids repitations and overlaping in data collection & storage.
  - Heavy element : An MIS can't be established overnight, long term planning is required.
  - Flexibility & ease of use : While building an MIS system all types of possible means, which may occur in future, are added to make it flexible. The MIS should be able to incorporate all those features that make it readily accessible to coide range of users with easy usability.

- Five Competitive Forces:-

Ques:- What are the competitive forces. How competitive forces shape strategy?

Solution:- Five competitive forces are:- (i) Buyer's Power (ii) Supplier's Power (iii) Threat of new entry (iv) Threat of substitution (v) Level of competition.

(i) Buyer's Power:- A buyer group is powerful if: It is concentrated on purchases in large volumes; the products it purchases from the industry are standard or undifferentiated; the industry's product doesn't save the buyer money.

(ii) Supplier's Power:- Suppliers can exert bargaining power on participants in an industry by raising prices or reducing the the quality of purchased goods and services.

(iii) Threat of New Entry:- New entrants to an industry bring new capacity, the desire to gain market share, and often substantial resources. The seriousness of the threat of new entry depends on the barriers present and on the reaction from existing competitors that entrants can expect. If barriers to entry are high and new comers can expect sharp retaliation from the entrenched competitors, obviously the newcomers will not pose a serious threat of entering.

(iv) Threat of Substitution:- By placing a ceiling on prices it can charge, substitute products or services limit the potential of an industry. Unless it can upgrade the quality of the product or differentiate it somehow, the industry will suffer in earning and possibly in growth. Manifestly, the more attractive the price-performance trade-off offered by substitute products, the firmer the lid placed on the industry's profit potential.

(v) Level of Competition:- An organisation should face the general competitive market, So, level of competition is an essential competitive force which should be taken care while upgrading the quality of any product of an organisation.

- Formulation of Strategy:- Once having assessed the forces affecting competition in an industry and their underlying causes, the corporate strategist can identify the company's strengths and weakness-es. The crucial strengths and weaknesses from a strategic standpoint are not company's posture vis-a-vis the underlying causes of each force. Then the strategist can devise a plan of action that can include
  (i) positioning the company so that its capabilities provide the best defense against the competitive forces, and/or
  (ii) influencing the balance of the forces through strategic moves, thereby improving the company's position; and/or
  (iii) anticipating shifts in the factors underlying the forces and responding to them, with the hope of exploiting change by choosing a strategy appropriate for the new competitive balance before opponents recognize it.

  Some approaches for strategy making in short are:
  a) Positioning the company: Strategy can be viewed as building defenses against the competitive forces or as finding positions in the industry where the forces are weakest.
  b) Influencing the balance: The balance of forces is partly a result of external factors and partly in the company's control.
  c) Exploiting industry change: Industry evolution is important strategically because evolution, it brings with it changes in the source of competition.

UML

Unified Modeling Language (UML)

- Standard diagrammatic notation for describing object-oriented software systems
  — class diagrams, use case diagrams, state charts, sequence diagrams, collaboration diagrams, etc.
- Used in the modelling phase of the software engineering process.

Use Cases: — A use case is a sequence of transactions in a system, whose task is to yield a measurable value to an individual actor of the system.

Use Case : Borrow a Book

Actors	Member, Librarian
Summary	The member borrows a book from the system
Precondition	The membership is valid and the borrower has no old debts to the system
Description	The member chooses a book that is not already lent and that s/he does not own. The Librarian assigns the Member as the borrower of that book and also states a deadline for returning the book.
Postcondition	The member has successfully borrowed the book.
Exceptions	1. If the Member has a dues to pay, the member will have to pay it first. 2. The member already owns the book. 3. The book is already lent.
Used use cases	Pay the fee.

Characteristics of Operating Systems:- (Weaknesses of Operating Systems)
Certain systems are unlikely to be efficient in providing value to the beneficiaries/customers:
— cohere the beneficiary is not the source of fund (the source is somewhere else)
— cohere there is information assymetry and the services is important to the beneficiary (may have impact on life/property)
— cohen the service provider enjoys a monopoly on near-monopoly.

Data Quality:- The data captured and recorded must have the following characteristics:
Timely ; Complete ; Accurate ; Reliable ; Relevant ; Configurable

Entity:- Something that exists & is distinguishable.
Record:- A set of data items are corresponding to an entity.
Field:- The individual data items are called fields.

Timely:- Data may be generated at different locations & may need to be transmitted to the information system. The property 'timeliness' requires the transmission to take place at an agreed time point.

Complete:- Data on all fields (different) must be available.
(Incomplete in case data on all fields are not available)

Accuracy:- Every attribute of an entity being measured has an (unknown) 'true' value. The difference between the observed value and the true value is called bias or 'lack of accuracy'.

Note:- The problem of bias/inaccuracy is most severe in financial/social/performance measurement system.

Principal-Agent Theory:- It states that many systems have principals interested in system performance and agents carrying out activities. The problem of inaccuracy is likely to be most severe in case of an information assymetry between the principal & agent. (This characteristic may lead to wilful misrepresentation).
When a complex system has many components and measurements are difficult, problems of inaccuracy may come inadvertantly.

Assessment of problem of inaccuracy :- [Balance check, Stationarity check

Balance check is applicable in systems where transfer of money or materials (measured in terms of quantity) takes place.
[Balance check essentially mean closing stock = Opening stock + Receipt - Consumption]
Typically the errors of balance checks are recorded and permissible quantum of errors are arrived at statistically.

Stationarity check is applicable to quantity data observable in chronological order, where some relationship is expected when the data are looked at on time scale.
It involves checking whether the data series observed over time is stationary or not.

Weak stationary condition :- The mean & variance of the series remains constant over time. Constant mean implies absence of trend. This is the most frequent check for data accuracy.

Example :- The difference between receipt and issue is not expected to have a trend (Supply, consumption of two different organization, receipt from outside source & issue to production)

Reliability :-
Operational Definition :- A specific definition about the measurement procedure including the method of taking samples, usage of measurement instrument, method of recording the observation, training/instruction for measurement.
Measurement Variation :- Instruments have certain amount of variation. The reported data will have at least the quantum of variation embedded in the basic measurement.
Note :- Combination of different measures (density, inflation, etc) are expected to have large variation as variation for different sources get added.
Reliability of a measurement :- The reliability of a measurement is its ability to produce similar values when a particular attribute of an entity is measured repeatedly. An unreliable measurement system has a large variation and hence individual measurements can't be relied upon.

Note:- A measurement system becomes unreliable due to following reasons:
- Lack of operational definition
- Inherent variability of the measurement instrument (including questionnaires, observations, interviews, opinions)
- Several measurements are combined to arrive at scores.

Relevance (Secondary characteristic):- Ability of the specific data item to produce insights (information) in the combination with other data items. (In this case we are looking at characteristics of other entities to bring out comparative or some other similar perspective)

Configurability (Secondary characteristic):- This ability allows the construction of several reports from the data system automatically.

Construct (Latent variables): An unobserved conceptual variable like intelligence, skill, satisfaction, etc. The underlying concept (i.e., the latent variable/construct) is well understood but can't be measured.

Indicator Variables (Manifest variables): Observable variables or direct options that supposedly help measure a construct.

Dimensions of a construct:- Various broad areas that define the overall construct.

Model:- A proposition regarding the relationship between the construct, their dimensions (factors) and manifest variables.

Construct Validity:- This is validity of the proposed model, i.e., construct validity ensures that the theorized factors truly consist of the identified manifest variables.

Content Validity:- In case the proposal dimensions together measure the overall construct, it is said to have content validity. Content validity requires studying the effect of the proposed dimensions on the overall construct by studying the impact of the proposed dimensions on some related variables (relevant variables).

Note about MIS:- An MIS consists of operational systems (restricted to specific areas of value chain) and methods to link the different operational systems (Some systems may not have the methods to link operational system — check for lifecycle data of different entities).

An effective MIS should be in a position to measure the effectiveness of the underlying system (i.e., whether the underlying system is reaching its goal or not and whether it meets the requirements of the users/customers or not). These measurements are often constructs and the designer should be clear about construct & content validity.

- **Design of MIS :-** Covers two aspects
  - Database system to address operational systems (DBMS)
  - Data warehouse system to address combination of data residing in different databases.

Database :- A system that allows users to describe, maintain, update and process records related to different entities. DBMS also have features to ensure that integrity of the database is maintained.

Integrity :- Existential & Referential.

- Existential: Checking whether a particular entity that may be used for processing exists.
- Referential: It requires that an entity referred to from a file (table) is there in the database.

Scheme of a Database :- Division of the records into smaller records such that maintainance of integrity is easier is called 'scheme design'. The specific division is called the schema. The schema needs to be designed in a manner so as to ensure that information is not lost.

Concept of DDL & DML :- Data Description Language is a language that enables us to describe the database schema. Data Manipulation Language is a method of processing a database to answer queries (generate reports).

Design of Schema :-
- Identification of different entities involved.
- Describing the relationship between the various entities.

Student Information System :- Students taking courses
Courses have subjects
Students taking subjects having marks

- **System Risk:-**

Risk: Probability of occurance of an undesirable event. (This event is called a risk event).

Exposure: A set of variables that have an impact on risk event.

System Risk: Probability of the undesirable event that the MIS does not produce desired results.

Failure mode: Different manifestations of the risk event.

System Risk:
- (a) The captured data may not yield the required information (failure to capture 'right data'): Data may not be operationally defined; formats may be inflexible; data may not have adequate granularity.
- (b) Failure of data supply (providers may not send the data) – failure to send on time, incomplete, inaccuriate, unreliable.
- (c) Failure to build the system or meet the quality requirements.

Failure to build system:-

Assumption:- The system needs to be implemented through software. The failure is inability to build the system on time, within budget and with required quality.

On time & within budget:- Failure to meet time and budgetary targets are primarily due to failure of estimation. (These estimates are essentially percentiles where we have a reasonable idea about the probability of completing the task within a given target).

Notes on failure to meet time & budget requirement:- The estimates are arrived at from two perspectives:

— **Target:** In these environments the 'estimates' are actually 'requirements'/'targets' specified from top. The targets are usually a lower percentile point & hence have a high risk of failure.

— **Statistical:** The actual efforts and budgets of previous MIS projects are known. The chance of completing the current project within different goals is estimated from this data.

- **Failure to meet quality requirements :–**

Construction related failures → time & budget (failure to estimate budget driven estimation)
→ quality related

Two types of quantities → Functional (functional requirements)
→ Non-functional (non-functional requirements)

Functional Quality Requirements :– Various functions the MIS is expected to perform primarily three areas —

– Capturing Data
– Maintainance & Modification of Data
– Presentation of reports / answering queries
(prestructured) (constructed – configurability)

Non-functional Quality Requirements :– These quality characteristics enhance smooth performance (operability) of the MIS. In addition, these characteristics ensure continuing suitability of the information system.

– Useability → Help features
→ Usage of standard conventions
→ Easy navigability

– Performance → Response rate (needs to be defined for specified number of users)

– Compatibility and inter-operability :
Compatibility refers to ability to use documents / products developed using previous version.
Inter-operability refers to the ability to use different operating system / hardware.

Efficiency – Ability to use computing resources efficiently (i.e. not using extra resources). Not very important from MIS stand point.

– Extensibility : Three types of changes –

Adaptive	Perfective	Corrective
change in the MIS due to change of hardware, software, environments.	changes to improve the performance (in the sense of information availability) of the MIS.	These changes are made to correct errors detected in a system.

Extensibility:-

Any MIS needs to be changed and there are 3 main types of changes as discussed. Extensibility refers to a design characteristic that facilitates change. This characteristic is also referred to as maintainability.

Extensibility depends on two characteristics :-

- Modularity
  - concept of localization
  (Modules should be independent & communicate through defined interfaces)
- Understandability
  - The different components of the system have clear objectives & methods of implementation known to the developer.

(d) The MIS (software implementing MIS) may not get used (or may be used minimally) — Fogg's behavioured model (persuasive design)

Fogg's behaviour model:-

- Motivation → Higher motivation ⇒ higher chances of using the system.
- Ability/effort → Extent of effort required to use.

Motivation
- Fear — Imposing punishment or withholding benefits in case the stated action is not carried out.
- Greed (Reward) — In case the system is adhered to the user will get visible benefit (advancement in job, better marks/price, make some mandatory job easier.)

Ability (Effort required)
- Learning curve (if learning time is high the system may fail)
- challenging existing practice — chances of failure becomes higher.
- Actual effort required (in case of the actual effort required is high system is likely to fail).

- Introduction to simple estimation (effort) methodologies :-
  - Bottom up methodology (Doesn't have any measure of size. Depends on existing abilities & technology).
  - consists of breaking up an MIS project into a number of activities.

[In case an estimate is violated an over-run is said to have happened]

Estimation of time & effort :-

- Bottom up methodology (i)
- Break up the MIS projects into a number of activities. (ii)

(i) Methodology to identify the tasks (activities) for developing MIS software.

(ii) Tasks are classified into different categories on the basis of predefined methods. Typical classifications are simple tasks, tasks with medium complexity & tasks with high complexity

Assess complexity of tasks :-

- Note that MIS project involves three broad activities.
  - Data capture
  - Data maintanance
  - Data manipulation (reporting / query answering).
- Each task can be allocated to one of the major activities and subsequently the level of complexity can be assessed by looking at the subtasks within each task (what are the subtasks like?).

[In a typical scenario elaborate description of subtasks are developed so that complexity assessment becomes objective]

- Collect data on tasks falling into specified groups.

[Assumption :
  - The method of grouping is correct, i.e., the group for the given classes can be modelled using a distribution & will have lower variance compared to all tasks.
  - The method of grouping continues to remain valid]

— Find average effort & variance of effort for each group (Note that we are estimating conditional means & variances and we are assuming that the conditional variances are smaller than the overall variance).

— The estimated effort is arrived at by adding the estimated effort of individual tasks (effort for individual tasks are estimated by their conditional means).

• Identification of tasks:-

Software Development Life Cycle :- (SDLC) :- The objective of SDLC is to identify the broad class of tasks required to be carried out for development of a system (conception to implementation).

[Note:- The task classification of capture, maintain, manipulate are primarily for construction and does not cover the entire life cycle.]

SDLC concept is proposed by Royce.

The first proposed model is called Waterfall model. (Linear Sequential)

Tasks identified in the waterfall model :-

— Feasibility study
  - Technical feasibility
    - Talent availability
    - Technical constraints
  - Financial feasibility
  - Implementation feasibility
— Requirement analysis
  - Requirement capture
  - Requirement model.
— Design
  - Architecture
  - Broad design
    - Detailed Design
    - High level design (HLD)
— Construction
  - Developing code
  - Unit testing of code
— Integration & testing
— Implementation & handover
— Maintenance (changes & upgradation)

• The waterfall model is a sequential design process, used in software development processes, in which progress is seen as flowing steadily downwards (like a waterfall) through the above given 7 steps.

Herbert Simon defined problem as technical & non-technical.

Technical → Implementation of solution does not require change of behaviour. (Nothing new needs to be learnt or done differently)

Non-technical → Requires behavioural changes. (New practices/different ways of doing things).

- **Requirement Analysis:-**

Gathering requirements (specifying the information that will be processed and the methods to be used for reporting) Generally the data to be captured, their definitions, their formats and reporting rules are specified at this stage.

[This activity identifies 'what' the MIS is expected to do. Usually this is captured in a descriptive manner or sometimes through use cases. This is often called requirement elicitation]

Note:- Requirement elicitation typically happens in a descriptive environment. Consequently the output is often ambiguous

- **Requirement model:-** The MIS may be looked at from two different perspectives.
  - Structural: The static relationship between different components of the system is captured.
  - Behavioural: Describes how the system will behave or how its behaviour will change as the system reacts to different inputs (different environmental changes).

Requirements
- Functional (Stated requirements)
- Non-functional (May not be stated)
  - Performance
  - Efficiency
  - Interoperability
  - Maintainable / Extensible

Checking the correctness of an MIS :— Ensuring that the MIS performs as required. The MIS should meet the functional & non-functional requirements.

Checking an MIS :- An MIS is checked from two different prospectives:

— The system may be looked at from a static perspective (called reviews). This is normally used to check non-functional properties like understandability and maintainability (Also check adherence to standard).

Static check attempts to cover completeness (whether the MIS addresses all required points)

— The behaviour of the system needs to be checked dynamically (when the system is running). The dynamic check is called testing & it reveals the behaviour of the system.

Artefact :- The output of different stages.

Software Testing :- A set of activities carried out on a software product (MIS as well as other products) to uncover faults.

Fault :- A condition in the developed product that leads to failure when executed.

Failure :- A situation when the product does not yield the specified result when specific inputs have been provided (Failure must be inability to meet documented standard).

Notes :- 1. Presence of fault does not necessarily imply failure: Faults may remain undetected for a long period. An important Corollary : Larger number of faults do not mean lower quality.

2. Testing can only uncover faults. It shows failures of a system. However, inability to uncover faults do not imply absence of faults.

Operational Profile:- Captures the relative frequency of different requirements/ use cases.

Note:- The different requirements usually have unequal frequency. In a library book issue/receipt will have much higher frequency compared to physical verification.

Severity:- Failure to meet stated requirement need not have same impact on the user.

Risk based testing:- A rule followed by testers to broadly classify requirements in terms of frequency of occurance & severity.

Risk based testing advocates testing the high-frequency-high-severity requirements thoroughly.

Type of Test:- Testing is divided in two broad types:-

— White Box testing : The execution of the program is taken into consideration, carried out during unit testing conducted at construction phase. Typically these tests are carried out on small segment of the product (mostly white box tests are carried out on the output of one programmer).

— Black Box testing : The program is considered as a black box (no access to internal structure) & only functionalities are tested.

Requirement → Architecture / High-level design

Code of individual segments and unit testing ← Detailed design / code segments

Coverage (in the context of White box tests) :- The extent to which the possible execution paths have been covered.

—— Statement coverage
—— Branch coverage
—— Condition coverage

Statement Coverage:- Enough test cases are written to ensure that each statement within the unit is executed at least once.

Branch Coverage:- We ensure that each branch of the conditional statements are executed.

Condition Coverage:- Each constituent condition within the boolean expression defining the condition are evaluated to true & false.

Black Box Test:- Check the functional requirements considering the system (product) as a black box (intervals are not known/not accessible)

Testing Life Cycle:- Describes the different types of test carried out during the entire system development. Three types of tests are carried out —

- Unit test:- during construction, essentially from white box perspective, often requires stubs - for complete execution as called modules may not be available, does not provide a full functional view.
  (Stub: A dummy routine that is used when the actual module is not available. It is assumed that the dummy routine returns values as required by the calling module).
- Integration test:- At this stage the integrated modules are tested for their functional correctness. These tests are carried out from 'black box' perspective.
- System test:- These tests are carried out post integration when the entire system is available as a product (At this stage, the unit & integration tests are supposedly completed). During System test the different non-functional requirements are tested.

- **System Test :~**

→ Volume Test: The ability of the system to respond to large volumes of data/text/communication.

→ Efficiency Test: Usage of various resources like CPU, memory, disk space (Important for Embedded systems & Big data scenario).

→ Recovery Test: How does the system react to hardware/failure, software/communication. Graceful exit from a failure scenario.

→ Usability test: In the system test perspective the following points are checked :

- following standard fonts, icons and symbols (look & feel test)
- Ergonomics — Placement of icons & navigability to facilitate communication with system (checking the standards suggested by experts) The design of screens is a matter of subject matter expertise and should not be left to developers.

- **Performance Test :~**

Though a part of overall system tests, it merits attention because of its wide spread usage.

Performance is usually defined as the response time.

Response time = total time in system
= Waiting time in queue + service time.

Note:- Performance requirement must be stated taking the arrival and efficiency into consideration.

Test from User perspective :- Two broad types

— User Acceptance Test (UAT) used for custom-built systems.
— Alpha and Beta tests used for general purpose systems.

General purpose Vs Custom-built information systems:-

Custom built systems are developed for specific clients on the basis of requirements collected from the client. These systems can't be used elsecohere.

General purpose systems are expected to work for many customers without change (Implement a developed product). eg. Tally.

In MIS scenario there are general purpose software that need to be customized and/or localized (sort of hybrid, eg. SAP, Oracle Application, finacle, Telecom billing). These system have a core and a customized localized part.

User Acceptance Test:- The custom-built system or the customized/localized part of a hybrid system need to be tested by the specific users. This test is called UAT. These tests are done for usability and correctness.

Alpha and Beta tests for General purpose System:-

Alpha test: The system is used by non-experts under guidance to see its usability and correctness.

Beta test: The system is used unsupervised and problems are reported.

Black box test - techniques of carrying out black Box tests:-

- Use case based testing (way in which an actor interacts with the system, here the actors are first identified)
- Transaction based testing (A transaction is defined to be a set of actions taken by a system with a specific objective)

Ex. • Opening an account for a particular type of client (say, personal banking)
• Opening a bank account & making transactions (any kind of account)

Alpha Test Vs. Beta Test

Alpha test is a type of acceptance testing; performed to identify all possible issues before releasing the product to everyday users or public. The focus of this testing is to simulate real users by using whitebox and blackbox techniques.

Beta testing of a product is performed by "real users" of the software application in a "real environment" and can be considered as a form of external user acceptance testing. Beta testing typically uses black box testing.

Difference between transaction based and use case based testing :-

→ A transaction may cut accross various sections of the system. Thus a transaction is likely to present a more comprehensive view of the system. e.g.- Book purchase & availability in a library.
- Number transfer & fund transfer for a mobile.
- ATM usage & convenience changes for a bank.

While transaction based tests often offer comprehensive views o/w unavailable, ensuring that all transactions have been covered (completeness) is a difficult issue to handle. e.g. An airtraffic control or airline reservation.

→ Use case based testing is carried out on the basis of interactions between 'actors' (role based) and 'systems'. Ensuring completeness of use cases is thus simpler. *

Static Verification :- (Reviews or Examination)

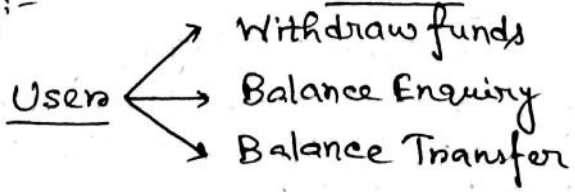
Verification of different artefacts of a system through examination called reviews.
(different documents produced as outputs of different stages of SDLC, e.g. requirement specification, architectural plan, i.e., the main components, etc)

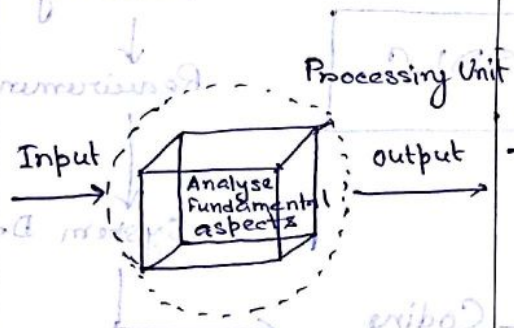
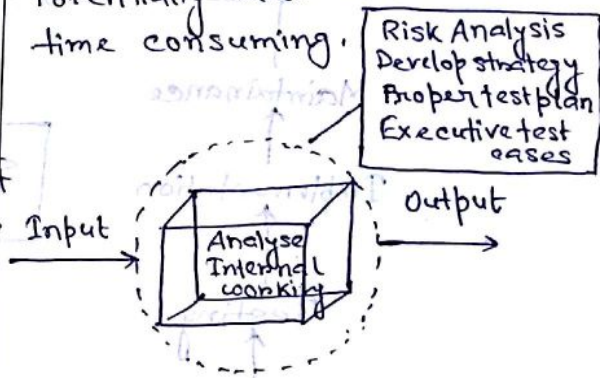
Advantages of static Verification:-

— Allows verifying artefacts from all stages.
— Allows an element of validation.
Checking whether the 'right' product is being developed or not.
Constitutes two steps : 1. Checking for completeness.
2. Checking for correctness at least for the major areas.

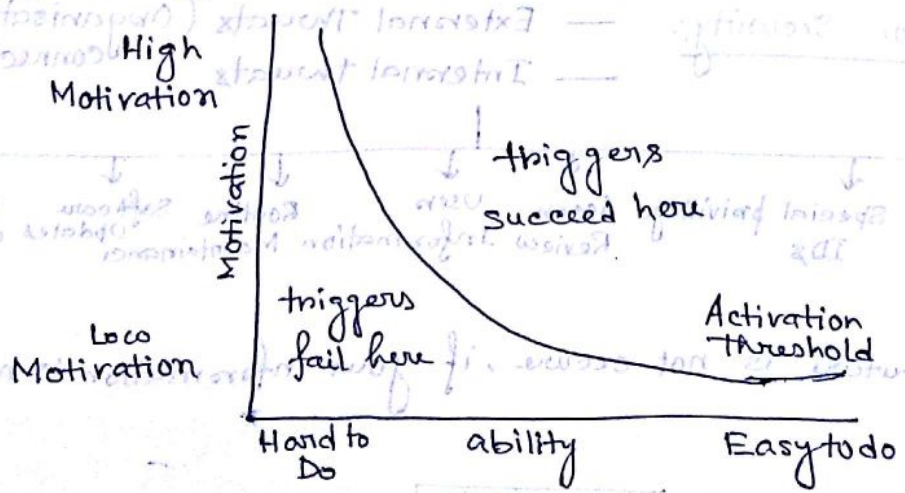
* Usecase testing is a technique that helps us to identify test cases that exercise the whole system on a transaction by transaction basis from start to finish.
Use cases use the business language rather than technical terms.

Example:-



Criteria	Black box testing	White box testing
Definition	Black box testing is a software testing method in which the internal structure/design/implementation of the item being tested is NOT known to the tester.	White box testing is a software testing method in which the internal structure/design/implementation of the item is tested is known to the tester.
Levels Applicable to	Mainly applicable to higher level of testing: Acceptance testing System Testing	Mainly applicable to lower levels of testing: Unit testing Integration Testing
Performed by	Performed by end users and also by tester and developers	Performed by developers and testers.
Time taken	It is least exhaustive and time consuming	Potentially most exhaustive & time consuming.
Representation		

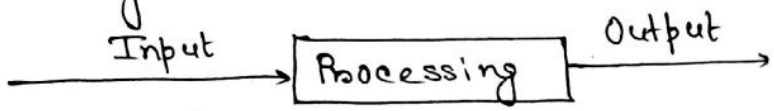
Fogg's Behavior Model:- Behavior model shows that three elements must converge at the same moment for a behavior to occur; Motivation, Ability and Trigger. When a behavior does not occur, at least one of the those three elements is missing.



System

A collection of components that work together to realize some objective forms a system.

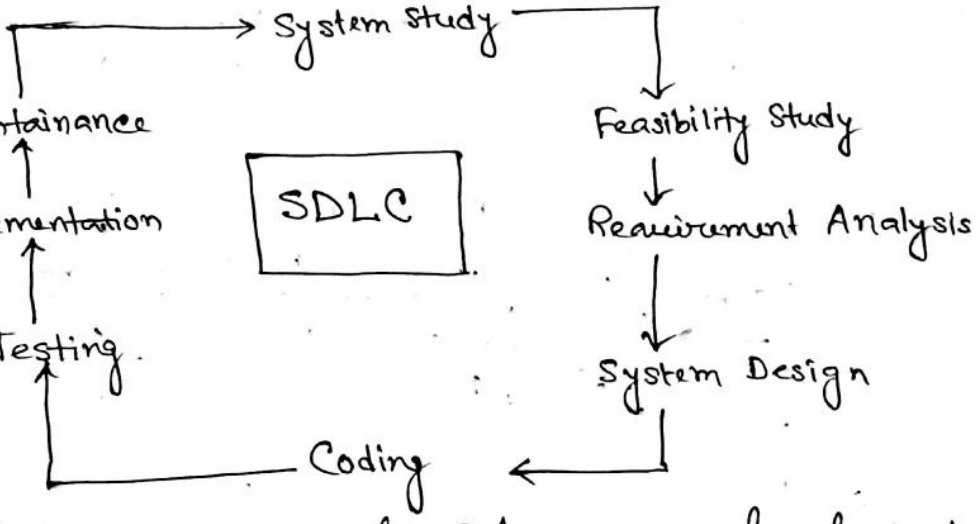
Three major components



Ex:- Human body, educational system.

System Life Cycle

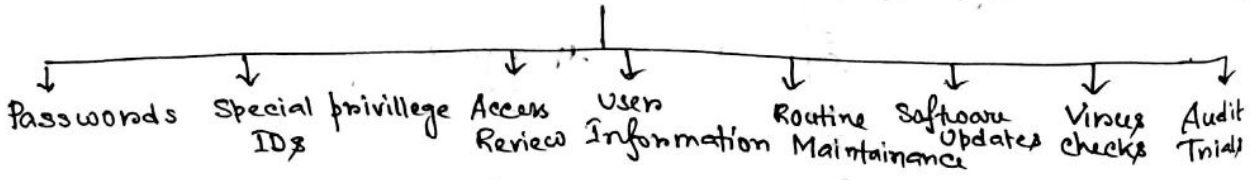
Organisational process of developing and maintaining systems.
Helps us to establish a system project plan.



Software Quality:- Ability of a Software to be fit for its purpose.

Quality factors:- Reliability, Connectness, Maintainability, Security, Reusability, Portability & User-friendliness

Information Security:-
— External Threats (Organisation's connection to internet)
— Internal threats



"Your future is not secure, if your information is not secure."

THE END