UNIT 1

What is OR?

- Analytical method
- Focuses on objectives (cost, profit)
- Involves strong understanding of the underlying system
- Helps in comparison of all possible alternatives with respect to their potential outcomes and then sensitivity analysis of the solution to changes (or errors) in numerical values
- *"OR is the application of the scientific method to the study of operations of large complex organizations or activities. It provides top level administrators with a quantitative basis for decisions that will increase the effectiveness of such organizations in carrying out their basic purposes"* – Committee on OR National Research Council of USA

Characteristics of OR

- Find optimum solution by using scientific methods to reach it
- Inter-disciplinary approach
- Optimize total output (maximizing profit, minimizing cost)

Phases of OR (Methodology)

1. Identification of problem
2. Formulation of problem
3. Constructing a model (physical, symbolic, deterministic, probabilistic)
4. Data collection
5. Substitution of data in model
6. Establishing control
7. Implementation

Applications of OR

- Marketing
- Finance
- Organization Behaviour
- Allocation and Distribution in Projects
- Research and Development
- Production and Facilities Planning

Tools of OR

- Linear programming
- Integer programming
- Assignment problems
- Transportation problems

Advantages of OR

Structured approach to problems

- A substantial amount of time and effort can be saved in developing and solving OR models if a logical and consistent approach is followed.
- This implies that the decision maker has to be careful while defining variables, availability of resources, and functional relationships among variables in the objective function and constraints.
- This also reduces the chances of conceptual and computational errors. Any such error can also be detected easily and corrected at an early stage.

Critical approach to problem solving

- The decision maker will come to understand various components of the problem and accordingly select a mathematical model for solving the given problem.
- He will become aware of the explicit and implicit assumptions and limitations of such models.
- Problem solutions are examined critically and the effect of any change and error in the problem data can be studied through sensitivity analysis techniques.

Disadvantages of OR

- Solution to a problem is often derived by simplifying assumptions. Such solutions are not optimal
- Models may not represent the realistic situations in which decisions are made
- The decision-maker is often not fully aware of the limitations of the models

Interdisciplinary Approach of OR

- OR utilizes a planned approach following a scientific method and an interdisciplinary team, in order to represent complex functional relationships as mathematical models.

- For solving any managerial decision problem, often interdisciplinary teamwork is essential.
- This is because while attempting to solve a complex management problem, one person may not have the complete knowledge of all its aspects such as economic, social, political, psychological, engineering, etc.
- Therefore, a team of various functional areas of management should be organized so that each aspect of the problem can be analyzed to arrive at a solution acceptable to all solutions of the organization.
- *"This new decision-making field has been characterized by the use of scientific knowledge through interdisciplinary team efforts for the purpose of determining the best utilization of limited resources"* – H A Taha (1976)

UNIT 3

Simulation

- **"A simulation is the process of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behaviour for the operation of the system"**
  – Shannon
- **"A simulated model may be defined as one which depicts the working of a large-scale system of men, machine, materials and information operating over a period of time in a simulated environment of the actual real-world conditions."**
  – Donald G. Malcolm
- Powerful and widely used management science technique for analysis and study of complex problems.
- Quantitative approach to decision making
- Logical extension of analytical and mathematical techniques using in OR problem solving
- Can be called management laboratory
- Determines the effect of alternate policies without disturbing the real system
- Representation (imitation) of reality in some physical form or in mathematical equations
- Basic idea: Build an experiment device that simulates the system of interest in important aspects
- Enables use of organizational improvement programs like Six Sigma

Need of Simulation

- Appropriate tool to use in solving a problem when experimenting on the real system
  - Would be disruptive
  - Would be too expensive
  - Does not permit replication
  - Does not permit control over key variables
- Desirable tool to use in solving a business problem when a mathematical model
  - Is too complex to solve
  - Is beyond the capacity of available personnel
  - Is not detailed enough to provide information on all important decision variable(s)
- Provides trial-and-error movement towards the optimal solution. Decision-maker selects alternative, experiences its effect, and improves the selection. Selection is adjusted until it approximates optimal solution
- When the problem is susceptible to description by a mathematical model but the analysis of the model is beyond the level of mathematical sophistication of the analyst

- When the problem is not susceptible to description by a mathematical model

Types of Simulation

- **Analogue Simulation**: Simulates the reality in a physical form. E.g., children cycling park, planetarium, chess
- **Computer/System Simulation**: Numerical technique involving mathematical and logical relationships using computers for conducting experiments, which involve complex real-world systems and intricate problems of managerial decision-making where analogue simulation cannot be implemented

Types of Simulation Models

- Deterministic Models: Input and output variables are not permitted to random variables. Models are described by exact functional relationships.
- Probabilistic Models: Method of random sampling is used. Technique used for solving is Monte-Carlo technique.
- Static Models: Do not take the time variable into account
- Dynamic Models: Deal with time-varying interactions

Simulation Methodology (Steps)

1. Identify and clearly define the problem
2. List the statement of objectives of the problem
3. Formulate the variables that influence the situation and an exact or probabilistic description of their possible values (or states)
4. Obtain a consistent set of values (or states) for the variables, i.e., a sample of what could happen.
   (simple for deterministic variables; random sampling for probabilistic variables)
5. Use the sample to calculate the value of the decision criterion, by following the relationships among the variables for each of the alternative decisions
6. Repeat steps 4 and 5 until a sufficient number of samples are available
7. Tabulate the various values of the decision criterion and choose the best policy

Advantages of Simulation

- Enables us to assess possible risks involved in a new policy before actually implementing it
- Easier to apply than pure analytical methods and less time-consuming
- In complicated systems, helps us to locate which variables have the most influence on system performance
- Knowledge obtained in designing and conducting the simulation is valuable and can be used for training
- Flexible

Disadvantages of Simulation

- Generates a way of evaluating the solution but does not generate the solution technique
- Quantification of variables may be difficult
- Large number of variables makes simulation unwieldy and difficult
- May not yield optimum results as it is a trial-and-error approach

Phases of Simulation

1. **Data Generation**: Involves the sample observation of variables and can be carried out with the help of any of the following methods:
    a. Using random numbers
    b. Resorting to mechanical devices
    c. Using computers
2. **Book Keeping**: Deals with updating the system when new events occur, monitoring and recording the system states as and when they change.
   Deals with keeping track of quantities of our interest (idle time, waiting time) to compute measures of effectiveness.