Chapter-1

Handout

# Operations Research

## Chapter # 1 Introduction

### Development of Operations Research

#### a) Pre World War II

Fredric W Taylor emphasized the application of scientific analysis to methods of productions. His aim was to find the weight of ore moved by shovel which would result maximum ore moved with a minimum fatigue. After many experiments, for a day, the proper weight turned out to be 20 pounds. Another man, Henry L Gantt, organized most of the job-scheduling methods. He mapped each job machine to machine minimizing every possible delay.

In 1917 A. K. Erlang published his work on the problem of congestion of telephonic traffic. The well known economic "lot size model" is attributed to F W Harris, who published his work on the area of inventory control. During the 1930's H C Levinson applied scientific analysis to problems of merchandising. His work included scientific study of customer's buying habits in response to advertising and relation to environment to the type of articles sold.

However it was the First Industrial Revolution which contributed mainly towards the development of Operations Research. This brought with it a new type of problem called "executive-type" of problem. The industry is divided into various types of departments called planning, sales, procurement, production, finance, marketing etc. The departments have their own specific tasks and targets. The objective of one department may be in the best interest of its own department but may clash with other departments. For example, the production department wants to have maximum production to lower the cost, which can be achieved by producing only one item in a very big lot-size (to reduce the fixed or setup cost). The marketing department wants a diverse inventory and flexible production. The finance department wants to reduce the lot-size to reduce the holding-cost. The personnel department wants to hire good labour and wants to retain and engage it with a uniform production. Hence a decision in the best interest of the organization called "Optimal Decision" is required.

#### b) World War II

During the World War II, the military management in England called on a team of scientists including physiologists, mathematical physicists, astrophysicists, and mathematicians. The object was to find out most effective allocation of limited military resources to various military operations and activities within the operations. The name operations (operational) research was coined because the team was carrying the research on operations.

#### c) Post – World War II

Very soon after World War II the idea of OR extended to industries. USA, Canada, France and other countries increased the potential of OR from military to government, industrial, social and economic planning. OR has been known by a variety names such as: Operational Analysis, Operations Evaluations, System Analysis, System Evaluation, System Research and Management Sciences.

## Definitions of Operations Research (OR)

1. OR is a scientific method of providing executive departments with a quantitative basis for decision regarding the operations under control. (Morse & Kimball)
2. OR can be characterised as the application of scienctific methods, tools and techniques to problems involving the operations of the systems so as to provide those in control of the operations with optimum solutions to problems. (Churchman, Ackoff, Arnoff)
3. OR is a scientific approach to problem solving for executive management. (H M Wagner)
4. OR is the art of giving bad answers to problems, to which otherwise, worse answers are given. (Thomas L Saaty)

## Characteristics of OR

1. System orientation
2. Use if interdisciplinary teams
3. Application of scientific methods
4. Discovering new problems
5. Improvement in quality of decisions
6. Computer application software
7. Quantitative solutions
8. Human factors

## Scientific Methods in OR

1. Judgement / Analysis Phase
2. Research Phase
3. Action / Implementation Phase

1. <u>Judgement / Analysis Phase</u>
   a) Determination of operation
   b) Determination of objectives & values associated
   c) Determination of effectiveness
   d) Formulation of the problem
      i. Remedial
      ii. Optimization
      iii. Transference
      iv. Prediction

2. <u>Research Phase</u>
   a) Observation and data collection
   b) Formulation of hypothesis / model
   c) Verification of hypotheses / model
   d) Prediction and generalization

## Necessity of OR

a) Complexity
b) Scattered responsibility
c) Uncertainty
d) Knowledge explosion

## Methodology of OR

1. Formulating the problem
    a. Environment
    b. Decision Maker
    c. Objective
    d. Alternatives
    e. Constraints
2. Construction of mathematical model
3. Deriving a solution from a model
4. Testing the model
5. Establishing controls
6. Implementation

## Classification Schemes of Models

1. <u>By degree of abstraction</u>
    a) Mathematical models (Linear Programming)
    b) Language models (Cricket or Hockey commentary)

2. <u>By function</u>
    a) Description models (Describing the situation)
    b) Prediction models (Forecast)
    c) Normative models (Decision Rules)

3. <u>By structure</u>
    a) Iconic or physical models (Building or aircraft)
    b) Analogue or schematic models (graphs, dials, organization charts)
    c) Symbolic or Mathematical models (Equation, functions)

4. <u>By nature of environment</u>
    a) Deterministic models (Variables are completely defined)
    b) Probabilistic models (Probabilities are attached to variables)

5. <u>By extent of generality</u>
    a) General models (Linear Programming)
    b) Specific models (Sales report)

6. <u>By the time horizon</u>
    a) Static models (One time decision)
    b) Dynamic models (Multistage decision)

## *Characteristics of good model*

1. No. of assumptions should be less
2. Few variables
3. Should assimilate the system environmental changes without change in its framework
4. Should be adaptable to parametric type of treatment

5. Should be economical

## *Advantages of a model*

1. It provides logical and systematic approach to the problems
2. It indicates the scope and limitations
3. It helps in improving a system and research
4. It makes an overall structure more comprehensible

## *Limitations of a model*

1. Models are the representation of reality and not reality itself.
2. The validity of a model is ascertained only by conducting experiments.

## *Construction of a model*

After the formulation of the problem the next step is to define the measure of effectiveness. The general form of an OR model is:

$$E = f(xi, yi)$$

Where:
E = effectiveness of the system
xi = variables of the system that can be controlled
yi = variables of the system that can not be controlled but affect it.

### Steps:

1. Selecting the components
2. Pertinence of components
3. Combining the components
4. Substituting the symbols

### Approximations in OR Models

1. Omitting certain variables
2. Aggregating variables
3. Changing the nature of variables
4. Changing the relationship of variables
5. Modifying the constraints

### Limitations of OR

1. Mathematical models do not take into account the qualitative factors or human behaviour.
2. Applicable only to a specific category.
3. Resistance among the employees and management to adopt new system.
4. Wrong implementation.
5. OR is meant for men, men are meant for OR.