UNIT 1: Introduction

Definition of Operation Research:

Uniform and acceptable definition of O.R. is not available.

However, few definitions available in literature are given below:

1. “Operation research is a scientific method of providing executive departments with a quantities basis for decisions regarding the operations under their control”.

2. “Operation research is concerned with scientifically deciding how best to design and operate man machine systems usually under conditions requiring the allocation of & care resources”. O.R. Society of America

3. “Operation research is a scientific approach to problem solving for executive management”. H.M. Warner

4. “O.R is the application of scientific method by interdisciplinary teams to problems involving the control of organized (men-machines) systems so as to provide solution which best serve the purpose of the organisation as a whole”.

5. “Operation research is an aid for the executive in making his decisions by providing him with the needed quantitative information based on the scientific method of analysis”.

6. “O.R in the most general sense can be characterized as the application of scientific methods techniques and tools to problems involving the operations of systems so as provide those in control of the operation with optimum solution to the problems”.

Operations research (OR) is an analytical method of problem-solving and decision-making that is useful in the management of organizations. In operations research, problems are broken down into basic components and then solved in defined steps by mathematical analysis.

The process of operations research can be broadly broken down into the following steps:

1. Identifying a problem that needs to be solved.
2. Constructing a model around the problem that resembles the real world and variables.
3. Using the model to derive solutions to the problem.
4. Testing each solution on the model and analyzing its success.
5. Implementing the solution to the actual problem.

Disciplines that are similar to, or overlap with, operations research include statistical analysis, management science, game theory, optimization

theory, artificial intelligence and network analysis. All of these techniques have the goal of solving complex problems and improving quantitative decisions.

The concept of operations research arose during World War II by military planners. After the war, the techniques used in their operations research were applied to addressing problems in business, the government and society.

Characteristics of operations research

There are three primary characteristics of all operations research efforts:

1. Optimization- The purpose of operations research is to achieve the best performance under the given circumstances. Optimization also involves comparing and narrowing down potential options.
2. Simulation- This involves building models or replications in order to try out and test solutions before applying them.
3. Probability and statistics- This includes using mathematical algorithms and data to uncover helpful insights and risks, make reliable predictions and test possible solutions.

Importance of operations research

The field of operations research provides a more powerful approach to decision making than ordinary software and data analytics tools. Employing operations research professionals can help companies achieve more complete datasets, consider all available options, predict all possible outcomes and estimate risk. Additionally, operations research can be tailored to specific business processes or use cases to determine which techniques are most appropriate to solve the problem.

Uses of operations research

Operations research can be applied to a variety of use cases, including:

- Scheduling and time management.

- Urban and agricultural planning.
- Enterprise resource planning (ERP) and supply chain management (SCM).
- Inventory management.
- Network optimization and engineering.
- Packet routing optimization.
- Risk management.

History of Operations Research

Operations Research (Operational Research, O.R., or Management science) includes a great deal of problem-solving techniques like Mathematical models, Statistics and algorithms to aid in decision-making. O.R. is employed to analyze complex real-world systems, generally with the objective of improving or optimizing performance.
In other words, Operations Research is an interdisciplinary branch of applied mathematics and formal science which makes use of methods like mathematical modeling, algorithms statistics and statistics to reach optimal or near optimal solutions to complex situations.
It is usually worried about optimizing the maxima (for instance, profit, assembly line performance, bandwidth, etc) or minima (for instance, loss, risk, cost, etc.) of some objective function. Operational Research aids the management to accomplish its objectives utilizing scientific methods.

Origin and History of Operations Research in Brief

While researching for **operations research (O.R.) history**, I discovered that history is not clear cut, different people have diverse views of the same event.
Based on the **history of Operations Research**, it is believed that Charles Babbage (1791-1871) is the father of Operational Research due to the fact that his research into the cost of transportation and sorting of mail resulted in England's universal Penny Post in 1840.
The name *operations research evolved in the year 1940*. During World War 2, a team of scientist (Blackett's Circus) in UK applied scientific techniques to research

military operations to win the war and the techniques thus developed was named as operation research.

As a formal discipline, operations research originated from the efforts of army advisors at the time of World War II. In the years following the war, the methods started to be employed extensively to problems in business, industry and society. Ever since then, OR has developed into a subject frequently employed in industries including petrochemicals, logistics, airlines, finance, government, etc.

Thus, the Operational Research began during World War II in great Britain with the establishment of groups of scientists to analyze the strategic and tactical problems associated with military operations. The aim was to discover the most efficient usage of limited military resources by the application of quantitative techniques.

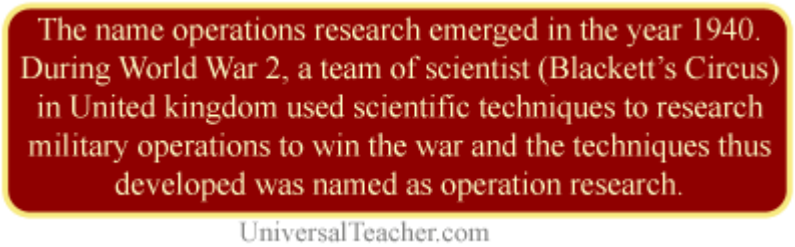

Figure – O.R. Origin

At the conclusion of war different things happened to O.R. in the Great Britain and in the United States. In the UK expenses on defense research were lowered; this resulted in the discharge of numerous Operational Research workers from the military at a time when business managers were facing the need to restore much of Britain's production facilities which had been ruined in war. Professionals in the nationalized basic industries, specifically, needed assistance from the OR men leaving the military organization.

To the contrary, defense research in US was increased and O.R. was expanded at the conclusion of war. The majority of the experienced workers stayed in the service of the army. The ultimate involvement of science in industrial problems of the executive type in the US is a result of the advent of Second Industrial revolution.

World war II had sparked scientific advances in the study of communication, computation, & control which produced the technological grounds for automation. In early 1950s industry started to take in a few of the Operational Research workers who left the army. Thus O.R. started to spread and expand in the United States.

MODELS OF OPERATIONS RESEARCH

Most operations research studies involve the construction of a mathematical model. The models of Operations research is a collection of logical and mathematical relationships that represents aspects of the situation under study. Models describe important relationships between variables; include an objective function with which alternative solutions are evaluated, and constraints that restrict solutions to feasible values.

A model is always an abstraction that is of necessarily simpler than the real situation. Elements that are irrelevant or unimportant to the problem are to be ignored; hopefully leaving sufficient detail so that the solution obtained with the model has value with regard to the original problem.

Models must be both tractable, capable of being solved, and valid, representative of the original situation. These dual goals are often contradictory and are not always attainable. It is generally true that the most powerful solution methods can be applied to the simplest, or most abstract, model.

VARIOUS MODELS OF OPERATIONS RESEARCH

The following are the various models of Operations Research:

1.**ANALYTICAL MODELS**

An analytical model is quantitative in nature, and used to answer a specific question or make a specific design decision. Different analytical models are used to address different aspects of the system, such as its performance, reliability, or mass properties.

Analytical models must be expressed with sufficient precision that they can be formally analyzed, which is typically by a computer.

Analytical models can be further classified as:

- Static Analytical Model
- Dynamic Analytical Model

A **static model** represents the properties of a system that are independent of time, or true for any point in time. The properties being analyzed may have deterministic values, or may include probability distributions on their values.

A **dynamic model** is an analytical model that represents the time-varying state of the system, such as its acceleration, velocity, and position as a function of time.

The selection of a dynamic model versus a static model depends on the type of question that is being answered.

2. SIMULATION MODELS

Simulation models aim to replicate the workings and logic of a real system by using statistical descriptions of the activities involved.

A simulation model has **'entities'** (e.g. machines, materials, people, etc.) and **'activities'** (e.g. processing, transporting, etc.). It also has a description of the logic governing each activity. For example, a processing activity can only start when a certain quantity of working material is available, a person to run the machine and an empty conveyor to take away the product. Once an activity has started, a time to completion is calculated, often using a sample from a statistical distribution.

The model is started and continues to run over time, obeying the logical rules that have been set up. Results are then extracted concerning delays, etc.

It is clear that simulation models can replicate a complex production system. They can be used to indicate the level of shared resources needed by the operation (e.g. forklift trucks or operators), the speed of lines, sizes of vessels or storage tanks, etc.

3. ANALOG MODELS

Analog models represent the physiological process using elements that are, to some degree, analogous to those in the actual process. Good analog models can represent the system at a lower level, and in greater detail, than systems models,

but not all analog models offer such detail. Analog models provide better representation of secondary features such as energy use, which is usually similar between analog elements and the actual components they represent.

4. **SYMBOLIC MODELS**

Symbolic Models also known as Mathematical Models are those which employ a set of symbols (i.e. letters numbers etc.) and functions to represent the decision variables and their relationships to describe the behavior or the system the symbols used generally mathematical or logical in character. They are by far the most widely employed in an O.R. study because of the great deal of complexity associated with an organization. A symbolic or mathematical model consists of a set of equations which define and specify the relationship and interactions among various elements of decision problem under study. The solution of the problem is then obtained by applying well-developed mathematical techniques to the model. The features of symbolic models are as follows:

- It contains a set of representations (or symbols) of something.
- It processes and manipulates those representations based on a set of rules programmed into the model.
- The rules operate on the representations according to their ‘shape’ or syntax, not according to what they represent (their semantics).

5. ICONIC MODELS

Iconic model is also known as Physical Model. Iconic model is a physical representation of some item either in an idealized form or on a different scale i.e. a representation is an iconic model to the extent that its properties are the same as possessed by what it represents. A photograph, cyclograph, a blueprint and a painting are iconic models of persons or objects. The toy aero plane is an iconic model of a real aero plane. Commonly an iconic model represents a static event.

DIFFERENCE BETWEEN ANALYTICAL AND SIMULATION MODELS OF OPERATIONS RESEARCH

BASIS OF DIFFERENCE	**ANALYTICAL MODELS**	**SIMULATION MODELS**

MEANING	Analytical analysis gives support to the idea theoretically and in mathematical equation.	Simulation analysis shows that the idea is practically implementable or not.
COMPLEXITY	These models try to include only most important aspects, so comparatively less complex.	These models are very complex and detailed.
FLEXIBILITY	These models are easier to change but small changes may bring big consequences.	These models are hard to change if built once.
DATA	These models need less to data to formulate.	These models need more data to formulate.
COMPUTATIONAL COST	These models incur less cost.	These models incur heavy cost.

DIFFERENCE BETWEEN SYMBOLIC AND ANALOG MODEL

BASIS OF DIFFERENCE	**ANALOG MODEL**	**SYMBOLIC MODEL**
MEANING	Analog model use one set of physical movements to represent another set of physical movements.	It is a mathematical model that represents a problem with the use of symbols.
PRESENTATION	They are presented in form of graphs, tables and curves.	They are presented in form of mathematical equation.
NATURE	The model is tangible.	The model is intangible.

Principles of Modeling

The model building and their applications both should be willfully aware of the following ten principles

1. Do not go for a complicated model when simple one will be sufficient
2. Models never substitute decision makers
3. The deduction phase of modeling must be carry out carefully
4. Models should be authenticate prior to implementation
5. A model should never be taken excessively literally
6. Be careful while molding the problem to fit the technique
7. A model should neither be pushed to do nor condemned for failing to do that for which it was never assumed
8. Some of the major benefits of modeling are linked with the procedure of developing the model
9. Be careful of over-selling a model
10. A model cannot be better than the information that goes into it

Applications of Operation Research:

O.R. is a problem solving and decision taking technique. It is considered a kit of scientific and programmable rules which provides the management a "quantitative basis" for decisions concerning the operation under its control.

Some areas of management where O.R techniques have been successfully utilized are as follow:

1. Allocation and Distribution in Projects:

(i) Optimal allocation of resources such as men materials machines, time and money to projects.

(ii) Determination and deployment of proper workforce.

(iii) Project scheduling, monitoring and control.

2. Production and Facilities Planning:

(i) Factory size and location decision.

(ii) Estimation of number of facilities required.

(iii) Preparation of forecasts for the various inventory items and computation of economic order quantities and reorder levels.

(iv) Scheduling and sequencing of production runs by proper allocation of machines.

(v) Transportation loading and unloading,

(vi) Warehouse location decision.

(vii) Maintenance policy decisions.

3. Programmes Decisions:

(i) What, when and how to purchase to minimize procurement cost.

(ii) Bidding and replacement policies.

4. Marketing:

(i) Advertising budget allocation.

(ii) Product introduction timing.

(iii) Selection of advertising media.

(iv) Selection of product mix.

(v) Customer's preference of size, colour and packaging of various products.

5. Organization Behaviour:

(i) Selection of personnel, determination of retirement age and skills.

(ii) Recruitment policies and assignment of jobs.

(iii) Recruitment of employees.

(iv) Scheduling of training programs.

6. Finance:

(i) Capital requirements, cash flow analysis.

(ii) Credit policies, credit risks etc.

(iii) Investment decision.

(iv) Profit plan for the company.

7. Research and Development:

(i) Product introduction planning.

(ii) Control of R&D projects.

(iii) Determination of areas for research and development.

(iv) Selection of projects and preparation of their budgets.

(v) Reliability and control of development projects thus it may be concluded that operation research can be widely utilized in management decisions and can also be used as corrective measure.

Importance of Operation Research in Decision Making

Undoubtedly, decisions hold immense significance in an organisation. For enhanced decision-making and problem-solving, operation research is pivotal. A decision can be made after analysing all the relevant information, facts and data. This is where operation research proves utilitarian. Operation Research is considered to be the most supportive means in management because it can help in resolving any uncertain or complex problem easily.

Different methods such as stimulation, queuing theory, game theory, mathematical & network analysis which are part of operation research are considered as major helpers in the decision-making process.

There are various reasons for which operation research can be significant in decision making and in management. For an organisation's growth, decisions, controlling, productivity as well as coordination rule over other components. In this sense, operation research is also imperative as it leads to well-informed decisions. This, in turn, garners different benefits for the organisation.

- `Effective Decisions`

Operation Research helps the managers to make well-informed and effective decisions. It is Operations Research that brings various alternatives at the disposal of managers. So, they can then assess the alternatives, the risks pertaining to each and the results of implementing each alternative. Furthermore, it also allows managers to analyse the effect of each alternative on the management. In this way, Operation Research helps to make better decisions in less amount of time. **Better Coordination**

Every department of an organisation has different decisions to be made according to their personal goals and objectives. Effective operation research coordinates every department's decisions in the best way.

- **Enhanced Control**

In management, operation research helps to distinguish the most important work from the list of work allotted. In this way, it facilitates the managers to prioritise tasks. So, the manager can perform the most significant work by himself and allot the remaining work to the subordinates to be completed in the given time. The manager can then set standards for the work so as to assess the subordinate's ability and presentation. After the completion of work, any divergence found can easily be corrected by the manager. Hence, operation research in management helps to facilitate control of the subordinates by the manager.

- **Improves Productivity**

In terms of productivity, operation research aides the organisations in taking proper decisions regarding the selection of warehouses, factories, manpower and their planning. It facilitates planning and control of inventory and production capabilities. Different techniques such as mathematical as well as statistical techniques can be taken into consideration to enhance the overall productivity of an organisation. Furthermore, simulation can also be used as a powerful productivity improvement method.

Clearly, these points show the importance of operation research in the decision-making process. Every manager must carry out operation research in order to find solutions to uncertain issues and make well-informed decisions. So, along with subjective knowledge, management aspirants must be trained to employ operation research strategies in order to make well-informed decisions.

At MIT School of Distance Education (MIT-SDE), we train our students in such a way that they become sound decision-makers. We familiarise them with the industry and its trends; train them of the fundamentals of management; sharpen their managerial as well as entrepreneurial skills and mould them as effective decision-makers. Our students are immediately absorbed in the industry. So, apply for our management courses and gain a competitive edge.