

Background (History of Operation Research)

Pre-World war II

The roots of OR are as old as science and society. Though the roots of OR extend to even early 1800s, it was in 1885 when Frederick W. Taylor emphasized the application of scientific analysis to methods of production, that the real start took place. Another man of early scientific management era was Henry L. Gantt. Most job scheduling methods at that time were rather haphazard. A job, for instance, may be processed on a machine without trouble but then wait for days for acceptance by the next machine. Gantt mapped each job from machine to machine, minimizing every delay. Now with the Gantt procedure it is possible to plan machine loadings months in advance and still quote delivery dates accurately.

In 1917, A.K. Erlang, a Danish mathematician, published his work on the problem of congestion of telephone traffic. The difficulty was that during busy periods, telephone operators were many, resulting in delayed calls. A few years after its appearance, his work was accepted by the British Post Office as the basis for calculating circuit facilities. The well-known economic order quantity model is attributed to F.W. Harris, who published his work on the area of inventory control in 1915.

During the 1930s, H.C. Levinson, an American astronomer, applied scientific analysis to the problems of merchandising. His work included scientific study of customers' buying habits, response to advertising and relation of environment to the type of article sold.

However, it was the First Industrial Revolution which contributed mainly to- wards the development of OR. Before this revolution, most of the industries were small scale, employing only a handful of men. The advent of machine tools- the replacement of man by machine as a source of power and improved means of transportation and communication resulted in fast flourishing industry. It became increasingly difficult for a single man to perform all the managerial functions (of planning, sale, purchase, production, etc.). Consequently, a division of manage- ment function took place. Managers of production, marketing, finance, personnel, research and development etc., began to appear. With further

industrial growth, further subdivisions of management functions took place. For example, production department was sub-divided into sections like maintenance, quality control, procurement, production planning, etc.

World War II

During World War II, the military management in England called on a team of scientists to study the strategic and tactical problems of air and land defence. This team was under the direction of Professor P.M.S. Blackett of University of Manchester and a former naval officer. 'Blackett circus', as the group was called, included three physiologists, two mathematical physicists, one astrophysicist, one army officer, one surveyor, one general physicist and two mathematicians. Many of these problems were of the executive type. The objective was to find out the most effective allocation of limited military resources to the military operations and to the activities within each operation.

The application included the effective use of newly invented radar, allocation of British Air Force Planes to missions and the determination of best patterns for searching submarines. This group of scientists formed the first OR team.

The name operations research (or operational research) was apparently coined because the team was carrying out research on (military) operation, the encouraging results of these effort led to the information of more such teams in British armed services and the use of scientific teams soon spread to western allies-the united states, Canada and France. Thus through this science of operation research originated in England, the united states soon took the lead, in united states these OR teams helped in developing strategies from mining operations, inventing new flight patterns and planning of sea mines.

Post-world war II:

Immediately after the war, the success of military teams attracted the attention of industrial managers who were seeking solutions to their problems. Industrial operation research in U.K. and U.S.A. developed along different lines. In U.K., the critical economic situation required drastic increase in production efficiency and creation of new markets.

Nationalization of a few key industries further increased the potential field for OR. Consequently OR soon spread from military to government, industrial, social and economic planning.

In U.S.A. the situation was different. Impressed by its dramatic success in U.K., defense operations research in U.S.A was increased. Most of the war experienced OR workers remained in military service. Industrial executives did not call for much help because they were returning to the peace-time situation and many of them believed that it was merely a new application of an old technique Operation research by a variety of names in that country such as operational analysis, operation evaluation, systems analysis, system evaluation, system research and management science.

The progress of industrial operational research in U.S.A. was due to advent of second industrial revolution which resulted in automation-the replacement of man by machine as a source of control, the new revolution began around 1940s when electronic computers became commercially available. The electronic brains processed tremendous computational speed and information storage. But for these digital computers, operation research with its complex computational problems could not have achieved its promising place in all kinds of operational environments.

In 1950, OR was introduced as a subject for academic study in American universities since then this subject has been gaining ever increasing importance for the students of Mathematics, Statistics, Commerce, Economics, Management and Engineering. To increase the impact of operation research, the Operations Research Society of America was formed in 1950. In 1953, the Institute of Management Sciences (IMS) was established. Other countries followed suit and in 1959 Inter- national Federation of OR began to appear. Some of them are:

Operations Research

Opsearch

Operational Research Quarterly

Management Science

Transportation Science

Mathematics of Operations Research

International Journal of Game Theory, etc.

Today, the impact of operations research can be felt in many areas. This is shown by the ever increasing number of educational institutions offering this subject at degree level. Of late, OR activities have spread to diverse fields such as hospitals, libraries, Planning, transportation systems, management, defense, etc

Nature and Definition of Operations Research

Defining Operations Research itself is very difficult. Like many other subjects that developed pragmatically and shade imperceptibly into adjoining subjects, it is more easily recognized than defined.

Generally speaking, operations research is an approach to the analysis of operations that to a greater or lesser extent adopts:

- (i) Scientific method (observation, hypothesis, deduction and experimentation as far as possible).
- (ii) The explicit formulation of complex relationships.
- (iii) An inter-disciplinary nature.
- (iv) A non-partisan attitude.

Operational Research can also be regarded as a scientific approach to the analysis and solution of management problem.

The council of the United Kingdom Operational Research Society defines Operational Research as “the attack of modern science on complex problems, arising in the direction and management of large systems of men, machines, materials and money in industry, business, government and defence. It goes on to state the distinctive approach as to

develop a scientific model of the system; incorporating measurement of factors such as chance and risk, in order to predict and compare the outcomes of alternative decisions, strategies and controls. The purpose is to help management to determine its policy and action scientifically”.

Daellenbach and George, (1978) defined Operation Research as the systematic application of quantitative methods, techniques and tools to the analysis of problems involving the operation of systems.

Other definitions imply view of Operation Research as being the collection of models and methods which have developed largely independent of one another. Thierauf and Klekamp, (1975) defined Operations Research utilizes the planned approach (updated scientific method) and an interdisciplinary team in order to represent complex functional relationships as mathematical models for the purpose of providing a quantitative basis for decision-making and uncovering new problems for quantitative analysis.

It is also worth pointing out that an Operations Research project is often a team effort that involved people drawn from many different backgrounds including: Accountants, Engineers, Mathematicians, Statisticians and Scientist as well as the operations research experts themselves.

Characteristics of Operation Research

1. System Orientation of Operation Research

One of the most important characteristics of Operations Research study is its concerned with problem as a whole or its system orientation. This means that an activity by any part of an organization has some effect on the activity of every part. Therefore, to evaluate any decision one must identify all possible interactions and determine their impact on the organization as a whole.

2. The Use of Interdisciplinary Team.

Operations Research study is performed by a team of scientists whose individuals members have been drawn from different scientific and engineering disciplines. For example, one may find a mathematician, statistician, physicist, psychologist, economist and engineers working together on an Operations Research problem.

3. Application of Scientific Method

Sometimes, we have to use the scientific method for solving the problem of Operations Research. It is not related to laboratories experiment like physics or biology or chemistry but it related by to the real life experiment. For example, no company can risk its failure in order to conduct a successful experiment. Though, experimentations on subsystem is some time resorted to, by and large, a research approach that does not involve experimentation on the total system is preferred.

4. Quantitative Solutions

It provides the management with a quantitative basis for decision making.

5. Human Factor

Human factor is an important component of the Operations Research study. Without human factor Operations Research study is incomplete.

Phases of Operation Research

Operations Research study generally involves the following phases;

1. The Formulation of the Problem

To find the solution of the Operations Research problem, you must have to formulate the problem in the form of an appropriate model. The following information will be required for this;

- a) Decision Maker

- b) Objective
- c) Controllable Factors (Variables)
- d) Uncontrollable Factors (Variable)
- e) Restrictions or Constraints

It might be of a functional nature as in linear programming or have a logical structure as in simulation and algorithms. E.g.

$$\text{Minimize } C = 4x + 5y \quad (1.1)$$

Subject to:

$$x + 3y \geq 6 \quad (1.2)$$

$$x + y \geq 3 \quad (1.3)$$

$$x, y \geq 0, \quad (1.4)$$

which is a linear programming model.

2. **Data Collection**

It involves obtaining quantitative data either from existing records or a new survey that fits well into the constructed model of the problem.

3. **Driving the Solution from the Model**

This involves the manipulation of the model to arrive at the best (optimal) solution to the problem. It may require solving some mathematical equations for optimal decisions as in calculus or linear programming models. It may also be a logical approach or a functional approach which does not require solving a mathematical equation, such as in queuing theory. The optimal solution is then determined by some criteria.

4. Testing the Model and Its Solution

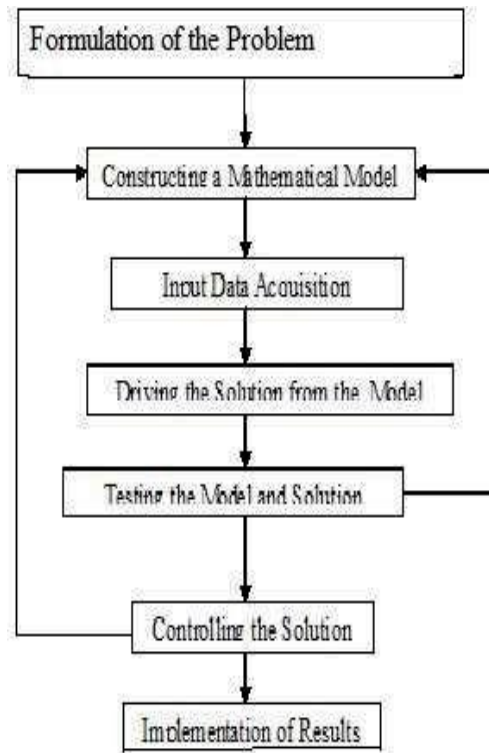
After getting solution, it is necessary to test the solution for errors if any. This may be done by re-examining the formulation of the problem and comparing it with the model that may help to reveal any mistakes.

5. Controlling the Solution

This phase establishes controls over the solution with any degree of satisfaction. The model requires immediate modification as soon as the controlled variables (one or more) change significantly; otherwise the model goes out of control. As the conditions are constantly changing in the world, the model and the solution may not remain valid for a long time.

6. Implementation of Model

The final phase of an Operations Research is to implement the optimum solution derived by the Operations Research team. As the conditions are constantly changing in the world, the model and the solution may not remain valid for a long time. Therefore, as the change occurs, it has to be detected as soon as possible so that the model, its solution and the resulting course of action can be modified accordingly. See the figure below



Phases of Operation Research