* 1. **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.

“OR is the application of the theories of probability, linear programming ,queuing theory etc to the problem of war and industry”

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

* + 1. Scientiﬁc method (observation, hypothesis, deduction and experimentation as far as possible).
    2. The explicit formulation of complex relationships.
    3. An inter-disciplinary nature.

A non-partisan attitude

* 1. **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.

* + 1. **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.

* + 1. **Application of Scientiﬁc Method**

Sometimes, we have to use the scientiﬁc method for solving the problem of Op- erations 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.

* + 1. **Quantitative Solutions**

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

* + 1. **Human Factor**

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

* 1. **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 formu- late the problem in the form of an appropriate model. The following information will be required for this;

* + - 1. Decision Maker
      2. Objective
      3. Controllable Factors (Variables)
      4. Uncontrollable Factors (Variable)
      5. 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.

*Minimize C* = 4*x* + 5*y*

Subject to:

*x* + 3*y* ≥ 6

*x* + *y* ≥ 3

*x, y* ≥ 0*,* (

which is a linear programming model.

* + 1. **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.

* + 1. **Driving the Solution from the Model**

This involves the manipulation of the model to arrive at the best (optimal) so- lution 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.

* + 1. **Testing the Model and Its Solution**

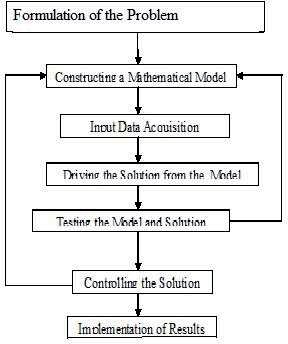
After getting solution, it is necessary to test the solution for errors if any. This may be done by re-examining the formulation of the problem and comparing it with the model that may help to reveal any mistakes.

* + 1. **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.

* + 1. **Implementation of Model**

The ﬁnal phase of an Operations Research is to implement the optimum solu- tion 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

* 1. **Quantitative Techniques of Operation Research**

Operation Research as its name suggests, gives stress on analysis of operations as a whole. For this purpose, it uses any suitable techniques or tools available from the ﬁelds of mathematics, statistics, cost analysis or numerical calculations. Some of these techniques are listed bellow;

1. Linear Programming
2. Non-linear Programming
3. Integer Programming
4. Dynamic Programming
5. Goal Programming
6. Game Theory
7. Inventory Control
8. Simulation
9. Queuing Theory
   1. **Scope of Operation Research**
      1. **In Industry**

Operation Research has been successfully applied in industry in the ﬁelds of pro- duction, blending product mix, inventory control, demand forecast, sale and pur- chase, transportation, repair and maintenance, scheduling and sequencing, plan- ning and control of projects etc.

* + 1. **In Defence**

Operation Research has a wide scope for application in defence operations. All the defence operations are carried out by a diﬀerent agencies, namely air force, army and navy. Operation Research helpful for achieving the desired goals of diﬀerent agencies.

* + 1. **In Planning**

Operation Research is helpful for planning of various activities of the organization. Planning is the important function of management, without eﬀective planning, we cannot achieve the desired goals.

* + 1. **In Agriculture**

Operation Research needs to be equally developed in agriculture sector on national or international basis. Every country is facing the problem of optimum allocation of land to various crops in accordance with the climatic conditions and optimum distributions of water from various resources like canal for irrigation purposes. Thus, there is a need of determining best policies under the prescribed restrictions.

**Advantages of OR**

1. It compels the decision maker to be quite explicit about his objective, as- sumptions and his perspective to constraints.
2. It makes the decision maker to very carefully about what variables inﬂuence the decisions.
3. Quickly points out gaps in the data required to support workable solutions to a problem.
4. Its models can be solved by a computer, thus the management can get enough time for decisions that require quantitative approach.

**Limitations of OR**

1. Often solution to a problem is derived either by making it simpliﬁed or simplifying assumptions and thus, such solutions have limitations.
2. Sometimes models do not represent the realistic situations in which decisions must be made.
3. Often decision maker is not fully aware of the limitations of the models that he is using.
4. Many real world problems just cannot have an OR solution.
   1. **Applications of Operation Research**

Some of the industrial/government/business problems which can be analysed by OR approach have been arranged by functional areas as follows;

1. Finance and Accounting
2. Marketing
3. Production Management
4. Personnel Management
5. Techniques and General Management
6. Stock re-ordering policies
7. Transport schedules
8. Product mix and Production ﬂows
9. Allocation problems i.e. which jobs should be allocated to which machines
10. Time wasted queuing at issuing, counters
11. Scheduling of activities in a complex project