BBA VI Semester

Subject- OPERATIONS RESEARCH
(OR)

TOPIC- Operations Research (Scope And Techniques)

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Operation Research:

Definition, Scope and Techniques

Meaning and Definition of Operation Research:
It is the method of analysis by which management receives aid for their decisions. Though the name of this method, Operation Research (O.R.) is relatively new, but the method used for this is not a new one. Operation Research is concerned with the application of the principles and the methods of science to the problems of strategy.

The subject of operation research was born during Second World War in U.K., and was used for military strategy. During World War II, a group of scientists, having representatives from mathematics, statistics, physical and social sciences were entrusted to the study of various military operations. This team was very successful and greatly contributed to the meticulous handling of entire operation and related problems of the operation.

The need for assigning such studies for operations arose because military strategies and their decisions become so important and costly and therefore, the best scientists, under the sponsorship of military organs were grouped together to provide quantitative information's by adopting scientific techniques and methods for facilitating in taking decisions.

After the World War II, it was started applying in the fields of industry, trade, agriculture, planning and various other fields of economy.

The operation research can be defined as:
Definitions:
(i) It is the application of scientific methods, techniques and tools to problems involving the operations of a system so as to provide those in the control of the system with optimum solutions to the problems.

(ii) Operation Research is a tool for taking decisions which searches for the optimum results in parity with the overall objectives and constraints of the organisation.

(iii) O.R. is a scientific method of providing executive department with a quantitative basis of decisions regarding the operations under their control.

(iv) O.R. is a scientific approach to problem solving for management.

(v) O.R. is an aid for executive in making his decisions by providing him with the needed quantitative information's based on the scientific method of analysis.

(vi) O.R. is the application of modern methods of mathematical science to complex problems involving management of large systems of men, machines, materials, and money in industry, business, government and defence. The distinctive approach is to develop a scientific model of the system incorporating measurement of factors such as chance and risk, to predict and compare the outcome of alternative decisions, strategies or controls.

(vii) It is the application of the scientific methods by scientists and subject specialists to the study of the given operation. Its purpose is to give administration, a basis for predicting quantitatively the most effective results of an operation under given set of variable conditions and thereby to provide a sound basis for "decision-making".

In fact in Operation Research, research techniques and scientific methods are employed for the analysis and also for studying the current or future problems. Thus, Operation Research offers alternative plans for a problem to the management for decisions.

Although it is very clear that operation research never make decisions for the management, instead the method presents management with a careful scientific and quantitative analysis of problem so that the management will be in a better position to make sounder decisions.

It can be used for solving different types of problems, such as:
i. Problems dealing with the waiting line, the arrival of units or persons requiring service.

ii. Problems dealing with the allocation of material or activities among limited facilities.

iii. Equipment replacement problems.

iv. Problems dealing with production processing i.e., production control and material shipment.

But it may be remembered that operation research never replaces a manager as decision maker. The ultimate and full responsibility for analysing all factors and making decision will be of the manager.

In the more wide sense, operation research does not deal with the everyday problems such as output by the one worker or machine capacity; instead it is concerned with the overall aspect of business operation such as something as the relationship between inventory, sales, production and scheduling. It may also deal with the overall flow of goods and services from plants to consumers.

The team doing operation research may have statisticians, psychologists, labour specialists, mathematicians and others depending upon the requirement for the problems.

Phases in Operation Research Study:

Since, the main objective of operation research is to provide better quantitative information's for making decision. Now our aim is to learn how we can have better decisions.

The procedure for making decisions with the OR study generally involves the following phases:

(i) Judgment Phase:

i. Determination of operation.

ii. Determination of objectives.

iii. Determination of effectiveness of measures.

iv. Determination of type of problem, its origin and causes.

(ii) Research Phase:

i. Observation and data collection for better understanding of the problem.

ii. Formulation of relevant hypothesis and models.

iii. Analysis of available information and verification of hypothesis.

iv. Production and generation of results and consideration of alternatives.

(iii) Action Phase:

i. Recommendations for remedial action to those who first posed the problem, this includes the assumptions made, scope and limitations, alternative courses of action and their effect.

ii. Putting the solution to work: implementation.

Without OR, in many cases, we follow these phases in full, but in other cases, we leave important steps out. Judgment and subjective decision-making are not good enough. Thus industries look to operation research for more objective way to make decisions. It is found that method used should consider the emotional and subjective factors also.

For example, the skill and creative labour are important factors in our business and if management wants to have a new location, the management has to consider the personal feeling of the employees for the location which he chooses.

Scope of Operation Research:

In its recent years of organised development, O.R. has solved successfully many cases of research for military, the government and industry. The basic problem in most of the developing countries in Asia and Africa is to remove poverty and hunger as quickly as possible. So there is a great scope for economist, statisticians, administrators, politicians and technicians working in a team to solve this problem by an O.R. approach.

On the other hand, with the explosion of population and consequent shortage of food, every country is facing the problem of optimum allocation of land for various crops in accordance with climatic conditions and available facilities. The problem of optimal distribution of water from a resource like a canal for irrigation purposes is faced by developing

country. Hence a good amount of scientific work can be done in this direction.

In the field of Industrial Engineering, there is a claim of problems, starting from the procurement of material to the despatch of finished products. Management is always interested in optimizing profits.

Hence in order to provide decision on scientific basis, O.R. study team considers various alternative methods and their effects on existing system. The O.R. approach is equally useful for the economists, administrators, planners, irrigation or agricultural experts and statisticians etc.

Operation research approach helps in operation management. Operation management can be defined as the management of systems for providing goods or services, and is concerned with the design and operation of systems for the manufacture, transport, supply or service. The operating systems convert the inputs to the satisfaction of customers need.

Thus the operation management is concerned with the optimum utilisation of resources i.e. effective utilisation of resources with minimum loss, under utilisation or waste. In other words, it is concerned with the satisfactory customer service and optimum resource utilisation. Inputs for an operating system may be material, machine and human resource.

O.R. study is complete only when we also consider human factors to the alternatives made available. Operation Research is done by a team of scientists or experts from different related disciplines.

For example, for solving a problem related to the inventory management, O.R. team must include an engineer who knows about stores and material management, a cost accountant a mathematician-cum-statistician. For large and complicated problems, the team must include a mathematician, a statistician, one or two engineers, an economist, computer programmer, psychologist etc.

Some of the problems which can be analysed by operations research are given hereunder:

1. Finance, Budgeting and Investment:

i. Cash flow analysis, long range capital requirement, investment portfolios, dividend policies,

ii. Claim procedure, and

iii. Credit policies.

2. Marketing:
i. Product selection, competitive actions,

ii. Number of salesmen, frequencies of calling on, and

iii. Advertising strategies with respect to cost and time.

3. Purchasing:
i. Buying policies, varying prices,

ii. Determination of quantities and timing of purchases,

iii. Bidding policies,

iv. Replacement policies, and

v. Exploitation of new material resources.

4. Production Management:
i. Physical distribution: Location and size of warehouses, distribution centres and retail outlets, distribution policies.

ii. Facilities Planning: Number and location of factories, warehouses etc. Loading and unloading facilities.

iii. Manufacturing: Production scheduling and sequencing stabilisation of production, employment, layoffs, and optimum product mix.

iv. Maintenance policies, crew size.

v. Project scheduling and allocation of resources.

5. Personnel Management:
i. Mixes of age and skills,

ii. Recruiting policies, and

iii. Job assignments.

6. Research and Development:
i. Areas of concentration for R&D.

ii. Reliability and alternate decisions.

iii. Determination of time-cost trade off and control of development projects.

Characteristics (Features) of Operation Research:

Main characteristics of operations research (O.R.) are follows:

(i) Inter-Disciplinary Team Approach:

This requires an inter-disciplinary team including individuals with skills in mathematics, statistics, economics, engineering, material sciences, computer etc.

(ii) Wholistic Approach to the System:

While evaluating any decision, the important interactions and their impact on the whole organisation against the functions originally involved are reviewed.

(iii) Methodological Approach:

O.R. utilises the scientific method to solve the problem

(iv) Objective Approach:

O.R. attempts to find the best or optimal solution to the problem under consideration, taking into account the goals of the organisation.

Methodology of Operation Research:

Operation Research, is a scientific approach for decision-making, and therefore must follow following steps:

1. Formulating the Problem:

The problem must be first clearly defined. It is common to start the O.R. study with tentative formulation of the problem, which is reformulated over and again during the study. The study must also consider economical aspects.

While formulating the O.R. study, analysts must analyse following major components:

(i) The environment:

Environment involves physical, social and economical factors which are likely to affect the problem under consideration. O.R. team or analysts must study the organisation contents including men, materials, machines, suppliers, consumers, competitors, the government and the public.

(ii) Decision-makers:
Operation analyst must study the decision-maker and his relationship to the problem at hand.

(iii) Objectives:
Considering the problem as whole, objectives should be defined.

(iv) Alternatives:
The O.R. study determines as to which alternative course of action is most effective to achieve the desired objectives. Expected reactions of the competitors to the alternative must also be considered.

2. Deriving Solution:
Models are used to determine the solution either by simulation or by mathematical analysis. Mathematical analysis for deriving optimum solution includes analytical or numerical procedure, and uses various branches of mathematics.

3. Testing the Model and Solution:
A properly formulated and correctly manipulated model is useful in predicting the effect of changes in control variables on the overall system effectiveness. The validity of the solution is checked by comparing the results with those obtained without using the model.

4. Establishing Controls over the Solution:
The solution derived from a model remains effective so long as the uncontrolled variables retain their values and the relationship. The solution goes out of control, if the values of one or more variables vary or relationship between them undergoes a change. In such circumstances the models need to be modified to take the changes into account.

5. Implementing the Solution:
Solution so obtained should be translated into operating procedure to make it easily understandable and applied by the concerned persons. After

applying the solution to the system, O.R. group must study the response of the system to the changes made.

Operation Research Models:

Operation Research model is an idealised representation of the real life situation and represents one or more aspects of reality. Examples of operation research models are: a map, activity charts balance sheets, PERT network, break-even equation, economic ordering quantity equation etc. Objective of the model is to provide a means for analysing the behaviour of the system for improving its performance.

Classification of Models:

Models can be classified on the basis of following factors:

1. By degree of Abstraction:

i. Mathematical models.

ii. Language models.

2. By Function:

i. Descriptive models.

ii. Predictive models.

iii. Normative models for repetitive problems.

3. By Structure:

i. Physical models.

ii. Analogue (graphical) models.

iii. Symbolic or mathematical models.

4. By Nature of Environment:

i. Deterministic models.

ii. Probabilistic models.

5. By the Time Horizon:

i. Static models.

ii. Dynamic models.

Characteristics of a Good Model:

i. Assumptions should be simple and few.

ii. Variables should be as less as possible.

iii. It should be able to asscimilate the system environmental changes without change in its framework.

iv. It should be easy to construct.

Constructing the Model:

A mathematical model is a set of equations in which the system or problem is described. The equations represent objective function and constraints. Objective function is a mathematical expressions of objectives (cost or profit of the operation), while constraints are mathematical expressions of the limitations on the fulfillment of the objectives.

These expressions consist of controllable and uncontrollable variables.

The general form of a mathematical model is:

$O = f(x_i, y_i)$

where O = Objective function

x_i = Controllable variables

y_i = Uncontrollable variables

f = Relationship between O, and x_i, y_i.

Since model is only an approximation of the real situation, hence it may not include all the variables.

Simplification in Operation Research Models:

While constructing the model, efforts should be made to simplify them, but only up to the extent so that there is no significant loss of accuracy.

Some of the common simplifications are:

i. Omitting certain variables.

ii. Aggregating (or grouping) variables.

iii. Changing the nature of variables e.g., considering variables as constant or continuous.

iv. Changing relationship between variables i.e., considering them as linear or straight line.

v. Modify constraints.

Techniques of Operation Research:

Important techniques of Operation Research are being described hereunder:

(i) Inventory Control Models:

Operation Research study involves balancing inventory costs against one or more of the following costs:

i. Shortage costs.

ii. Ordering costs.

iii. Storage costs.

iv. Interest costs.

This study helps in taking decisions about:

i. How much to purchase.

ii. When to order.

iii. Whether to manufacture or to purchase i.e., make and buy decisions.

The most well-known use is in the form of Economic Order Quantity equation for finding economic lot size.

(ii) Waiting Line Models:

These models are used for minimising the waiting time and idle time together with the costs associated therewith.

Waiting line models are of two types:

(a) Queuing theory, which is applicable for determining the number of service facilities and/or the timing of arrivals for servicing.

(b) Sequencing theory which is applicable for determining the sequence of the servicing.

(iii) Replacement Models:

These models are used for determining the time of replacement or maintenance of item, which may either:

(i) Become obsolete, or

(ii) Become inefficient for use, and

(iii) Become beyond economical to repair or maintain.

(iv) Allocation Models:

These models are used to solve the problems arising when:

(a) There are number of activities which are to be performed and there are number of alternative ways of doing them,

(b) The resources or facilities are limited, which do not allow each activity to be performed in best possible way. Thus these models help to combine activities and available resources so as to optimise and get a solution to obtain an overall effectiveness.

(v) Competitive Strategies:

Such type of strategies are adopted where, efficiency of decision of one agency is dependent on the decision of another agency. Examples of such strategies are game of cards or chess, fixing of prices in a competitive market where these strategies are termed as "theory".

(vi) Linear Programming Technique:

These techniques are used for solving operation problems having many variables subject to certain restrictions. In such problems, objectives are—profit, costs, quantities manufactured etc. whereas restrictions may be e.g. policies of government, capacity of the plant, demand of the product, availability of raw materials, water or power and storage capacity etc.

(vii) Sequencing Models:

These are concerned with the selection of an appropriate sequence of performing a series of jobs to be done on a service facility or machine so as to optimise some efficiency measure of performance of the system.

(viii) Simulation Models:

Simulation is an experimental method used to study behaviour over time.

(ix) Network Models:
This is an approach to planning, scheduling and controlling complex projects.

Applications of Operation Research:

These techniques are applied to a very wide range of problems.

Here only some of the common applications are being mentioned:

(i) Distribution or Transportation Problems:
In such problems, various centres with their demands are given and various warehouses with their stock positions are also known, then by using linear programming technique, we can find out most economical distribution of the products to various centres from various warehouses.

(ii) Product Mix:
These techniques can be applied to determine best mix of the products for a plant with available resources, so as to get maximum profit or minimum cost of production.

(iii) Production Planning:
These techniques can also be applied to allocate various jobs to different machines so as to get maximum profit or to maximise production or to minimise total production time.

(iv) Assignment of Personnel:
Similarly, this technique can be applied for assignment of different personnel with different aptitude to different jobs so as to complete the task within a minimum time.

(v) Agricultural Production:
We can also apply this technique to maximise cultivator's profit, involving cultivation of number of items with different returns and cropping time in different type of lands having variable fertility.

(vi) Financial Applications:
Many financial decision making problems can be solved by using linear programming technique.

Some of them are:

(i) To select best portfolio in order to maximise return on investment out of alternative investment opportunities like bonds, stocks etc. Such problems are generally faced by the managers of mutual funds, banks and insurance companies.

(ii) In deciding financial mix strategies, involving the selection of means for financing firm, projects, inventories etc.

Limitations of Operations Research:

i. These do not take into account qualitative and emotional factors.

ii. These are applicable to only specific categories of ddecision-making problems.

iii. These are required to be interpreted correctly.

iv. Due to conventional thinking, changes face lot of resistance from workers and sometimes even from employer.

v. Models are only idealised representation of reality and not be regarded as absolute.