Operations Research 1st Module

OR basically helps in determining the best (optimum) solution to problems where decisions need to be taken under the restriction of limited sources. It is possible to convert any real life problem into a mathematical model. The basic feature of OR is to formulate a real world problem as a mathematical model. In general, to manage the organisations concerned with lowering labour costs or production costs or transportation costs to achieve higher profits, OR can be very usefully employed to minimize the costs/ maximize the profits (Optimization).

EVOLUTION OF OPERATIONS RESEARCH (HISTORICAL DEVELOPMENT)

The term, operations research was first coined in 1940. This new science came into existence in a military contest. During World War-II, Military Management in England called upon a team of scientists to study the strategic and tactical problems related to air and land defence of the country.

They were having limited resources and it was necessary to decide upon the most effective utilization of them. (Effective ocean transportation, effective bombing etc). McClosky, and Trebthen of Bowdsey, United Kingdom used the term Operations Research in 1940 to describe this new science.

The OR teams were not actually engaged in military operations and fighting the war. But, they were only instrumental and advisors in wining the war by providing a good intellectual support to the strategic initiatives of the military commands (that is, "An art of wining the war without actually fighting"). As the team was dealing with research on military operations, the work of this team of scientists was named as Operations Research in England.

Following the end of war, the success of military teams attracted the attention of industrial managers who were seeking solutions to their complex executive type problems. Thus, it started spreading throughout the world and Society of Operations Research was formed in United States.
Today the impact of OR is felt on many areas. A large number of management consulting firms are currently engaged in OR activities.

DEFINITIONS OF OPERATIONS RESEARCH

Operations Research has been defined so far in various ways and it is perhaps still too young to be defined in some authoritative way. Students must understand that it is not possible to give uniformly acceptable definition of OR. A few opinions about the definitions of OR are,

"OR is the systematic application of quantitative methods, techniques and tools to the analysis of problems involving the operation of systems."
- Deallenbach and George – 1978

"OR is a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control"
- Morse and Kimbol – 1946

"OR is the scientific method of providing executives an analytical and objective basis for decision"
- P. M. S. Blackett – 1948

*Operations Research is a scientific approach to problem solving for Executive Management
- H. M. Wanger

"Operations Research is concerned with scientifically deciding how best to design and operate machine systems usually under conditions requiring the allocation of scarce resources",
- OR Society of America

"OR is the scientific knowledge through inter disciplinary team efforts for the purpose of determining the best utilization of limited resources"
- H. A. Taha

"Operations research is an art of winning a war without actually fighting"- Aurther Clarke

"Operations research is the application of the methods of science to complex problems arising in the direction and management of large systems of men, materials and money in industry, business, government and defense"
- Operations society of Great Britan

The above discussed definitions are given by various people at different times and stages of development of operations research lays emphasis on

(i) OR being a scientific technique
(ii) It is a problem solving technique
(iii) It is for the use of executives who have to take decisions for the organizations.A close observation will make it clear that, all the definitions are conveying the same meaning.

SCOPE OF OPERATIONS RESEARCH

OR basically helps in determining the best (optimum) solution to problems where decision has to be taken under the restriction of limited resources. Any organization involving operations

(transportation, job allocation, marketing) want to lower their operation costs to achieve higher profits, OR can be very usefully employed to this kind of real life problems.

With computers moving up the corporate ladder, the managers are increasingly using the operations research techniques for the purpose of decision - making with a view to arrive at optimal decisions. Thus, an understanding of various important techniques which can be used to aid the managerial decision making process is desirable for engineers / managers.

Industry has become quite aware of the potential of OR as a technique and many industrial and business houses have OR teams working to find solutions to their problems.
analysis

APPLICATION AREAS OF OR

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Some Important Applications of Operations Research

A. Production
(i) Scheduling and requesting the production run by proper allocation of machines
(ii) Calculating the optimum product mix.
(iii) Selection, location and decision of the sites for the production plans.

B. Purchasing Decision
(i) Inventory Management
(ii) Optimal re-ordering

C. Facilities Planning
(i) Transportation, loading and unloading
(ii) Planning warehouse locations
(iii) Factory/building location and size decisions

D. Construction Management.
(i) Location of resources to different projects
(ii) Work force/labour planning
(iii) Project management

E. Personnel
(i) Forecasting the man-power requirements, recruitment policies and job assignments
(ii) Selection of suitable personnel with due consideration for age and skills etc.

F. Research and Development
(i) Reliability and evaluation of alternative projects
(ii) Control of developed projects
(iii) Determination of time and cost requirements.

Apart from the above applications, its use has newly extended to a wide range of problems, such as the problems of communication, information, agriculture and national planning.

Indian Railways, Indian Airlines Tata Iron and Steel Company Life Insurance Corporation of India are few industries/ Organisation which have implemented the OR methodology

STEPS (PHASES) IN OR STUDY

The systematic methodology developed for an OR study deals with the problems involving conflicting multiple objectives, policies and alternatives.

The OR approach to problem solving consists of the following steps:

Formulation of the Problem: It involves description of the objective, identification of the decision variables and constraints of the system.

Construction of Mathematical Model: After formulating the problem, the next step is to construct a model for the system under study. It is usually a mathematical model. A mathematical model consists of a set of equations that describe the system.

Deriving the Solution from the Model: Once the Mathematical model is formulated, the next step is to determine the values of decision variables that optimize the given objective function. This deals with mathematical calculations for obtaining the solution to the model.

Validation of the Model: A model is valid if it can give reasonable predication of the performance of the system. The validity of a model is tested by comparing its performance with previous data available to the system. Comparison should reveal favorable results.

Controlling the Solutions: After testing the model and its solution, the next step is to establish control over the solution, by proper feedback of the information on variables which deviate significantly. In case of any deviation the model may be modified accordingly.

Implementation of the Final Results: Finally, the tested results of the model are implemented to work. For this, solution obtained above should be translated into operating procedures that can be easily understood and applied by those who control the operations.

CHARACTERISTICS OF OPERATIONS RESEARCH

Significant characteristics of operations research are as given below:

(I) Operations research is an inter-disciplinary team approach.

(II) Operations research uses scientific approach in obtaining optimum solution.

(III) The primary focus of operations research is on decision making and it enhances creative ability of a decision maker.

(IV) Operations Research is a wholistic approach (takes into account all significant factors and evaluates them as a whole)

(V) In situations where it is not possible to give perfect answer, operations research improves quality of solution.

(VI) Operations Research tries to optimize the total output by maximizing the profit and minimising the loss or cost

(VII) It relies mainly on a mathematical model in obtaining the optimal solution.

(VIII) Operations research is for operations economy.

(IX) Operations research approach provides the management with a quantitative basis for decision making.

(X) Computers can be used based on complexity of the model and computations to be made.

LIMITATIONS OF OPERATIONS RESEARCH

The use of operations research to improve decision making has become almost universal today. However, operations research has certain limitations as given below:

(I) Mathematical models are applicable to only specific categories of problems.

(II) Operations research may not give solution for many real world problems.

(III) Mathematical models (which are essence of OR) do not take into account qualitative factors such as human behaviour.

(IV) Constructing 'OR' model may be quite expensive for some problems when compared to sophisticated approaches available.

(V) Sometimes the basic data may be subject to frequent changes. In such cases, modification of OR models may be costlier affair.

(VI) Few OR models may be so complex that they cannot be solved without the aid of computers.

(VII) Solutions obtained from these models may be difficult to explain to the management which leads to fail in gaining their support and confidence.

MODELS IN OPERATIONS RESEARCH

A model is a theoretical abstraction of a real life problem. Modeling is the essence of an operations research approach. The complexities and uncertainties of a decision making problem can be simplified through modeling. In short, modeling is a means of proving a clear structural frame-work to the problem for purpose of understanding and dealing with reality symbolic models.

Models may be represented in a variety of ways. These can be classified as physical and symbolic models.

Physical models:

A physical model is a schematic representation of a real thing. There are two types of physical models namely iconic and analogue.

(I) Iconic models: these are basically the scaled- up/down versions of a particular thing. A model aero plane in a wind tunnel and a model of proposed building by an architect are examples of iconic models, because they look like what they represent (expect size).

These models are more specific and concrete.

(II) Analogue models: The analogue models use one set of properties to represent another set. For instance, an electrical network model may be used as an analogue model to study the flows in a transportation system. In general, the analogue models are less specific and concrete but they are easier to manipulate when compared to the iconic models.f

Symbolic models: Many real - time problems can be represented by symbolic models or mathematical forms. These are most general and abstract types of models. They employ letters, numbers and other types of symbols to represent the variables and their interrelationships. These are capable of experimental manipulation most easily. The symbolic models can be verbal or mathematical. Verbal models represent a situation in spoken language or written words, the mathematical models uses mathematical notation to represent the variables in a precise manner.

Symbolic models are used in operations research because they are easier to manipulate and they yield more accurate results compared to the iconic or analogue models.

Following are the main characteristics that a good OR model should have-

(i) The number of assumptions made should be as few as possible.
(ii) The model should be simple and coherent. The number of variables utilized by it should be small in number.
(iii) An OR model should take into account new formulations without having to make any significant changes.
(iv) It should be easy and economical to construct.
(v) It should be adaptable to parametric type of treatments

LINEAR PROGRAMMING (LP) PROBLEM

Linear programming is an optimization technique for finding an optimal (maximum or minimum) value of a function, called objective function, of several independent variables. The variables being subject to constraints (or restrictions) expressed as equations or inequalities.

Applications of Linear Programming Problems (LP)

The applications of Linear Programming (LP) are numerous and are increasing every day. Linear Programming is widely used in solving resource allocation problems. Production planning and scheduling, transportation, sales, financial planning are some potential application areas.

(I) Development of production schedule by minimizing total production and inventory costs to meet the future demands of a product.
(II) Selection of a product mix which maximizes the profits of a firm, subject to constraints.
(III) Selection of different blends of raw materials in feed mills to produce finished feed product at minimum cost.
(IV) Allocation of advertising budget among various media like TV, Radio, and Newspapers in order to maximize advertising effectiveness.
(V) Selection of an investment portfolio from a variety of stocks and bonds available in such a way as to maximize the return on investment
(VI) Determination of quantity to produce different grades of petroleum products in an oil refinery to yield the maximum profit.

(VII) Determination of a distribution system for minimizing total shipping cost from warehouses (source) to markets (destination).

Thus, LP is the most widely used technique of decision making in business and industry.

Assumptions in LPP

The important assumptions in linear programming problem are,

Proportionality: There exists a proportional relationship between objective and constraints.
Additivity: Total resources are equal to the sum of the resources used by individual activities.
Divisibility: Solution need not be a whole number decision variables can be in fractional form.
Certainity: Coefficients of objective function and constraints are known as constants and do not change.
Finiteness: Activities and constraints are finite in number.
Optimality: The ultimate objective is to obtain an optimal solution that is the maximization or minimization.

Definitions:

(i) Feasible Solution - Any point in the feasible region of a given problem is feasible solution
(ii) Feasible region - The Region in problem graph satisfying both constraints and non-negative region is called feasible region
(iii) Infeasible Region – Points that lie outside the feasible region that do not satisfy the constraints are infeasible region
(iv) CPF Solution – Corner points feasible solution is a feasible solution that doesn't lie on any line segment connecting two other feasible solution
(v) Degeneracy – when a basic variable acquires 0 value
(vi) Optimal Solution – The point in the feasible region that maximises/ minimises the objective function