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Operations research – Applications.

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ABSTRACT

Historical development of Operations Research, the name Operational Research was given various names in the United States: Operational Analysis, Operations Evaluation, Systems Analysis, Systems Research and Management Science. Today, the impact of operations research can be felt in many areas. Operations Research has wide range of applications in military, business applications, transportation system, libraries, hospitals, city planning, financial institutions etc. Operations Research can be applied to the different types of models and has various phases in problem solving.

Keywords: History of OR, Models and Phases and uses of OR.

INTRODUCTION

History of Operations Research

In order to understand 'what Operations Research' is today, we must know about its history and development. The word operations research was first coined during the world war-II. At that time, the military management in England is called upon the scientists from various disciplines to study and solve the strategic and tactical problems belonging to air and land defence of the country. Since they were having very limited resources, the team of scientists objective is to formulate specific proposals and plans to arrive at the decisions on optimal utilization of military resources and efforts and also to implement those decisions very effectively. Here, the team of scientists were not actually participated in military operations and fighting the war.

But they were only advisors and significantly effective in winning the war with the scientific and systematic approaches involved in OR provided a good support to the military commands. Hence we can call the OR as "an art of winning the war without fighting it".

Following the end of the war, the success of military attracted the Industrial managers who were required to seek solutions to their complex-type problems. Since then, in business and other organizations, OR specialists were always remain engaged in the background in helping the management and other managers.

To define anything non-trivial — like beauty or mathematics — is very difficult indeed. Here is a reasonably good definition of Operations Research:

Definition

Operations Research (OR) is an interdisciplinary branch of applied mathematics and formal science that uses methods like mathematical modeling, statistics, and algorithms to arrive at optimal or near optimal solutions to complex executive type problems. The definition of OR is

Problematic: to grasp it we already have to know, e.g., what is formal science or near optimality. From a practical point of view, OR can be defined as an art of optimization ,i.e., an art of finding minima or maxima of some objective function, and — to some extend — an art of defining the objective functions. The various objective functions are profit, transportation cost, yield of production, inventory, loss, waiting time in queue,

Operations Research has been defined so far by various authors in different ways, some of which are:

- OR is a scientific method for providing executive with an analytical and objective basis for decisions – P.M.S. Blackett (1948)
- OR is a scientific method of providing executive departments with a quantitative basis for decision regarding the operations under their control – Morse and Kimbal (1946)
- OR is the art of giving bad answers to the problems to which otherwise worse answers were given – T.L. Saaty (1958)
- OR is the art of winning war without actually fighting it.
- OR is a scientific approach to problem solving for executive management – H.M. Wagner

Thus, from an organizational point of view, OR is something that helps management achieve its goals using the scientific process.

MODELS IN OPERATIONS RESEARCH

The model in OR is defined as a representation of an actual object or situation. It shows the direct or indirect relationship and inter-relationships of action and reaction in terms of cause and effect.

The main objective of the model is to provide means for analyzing the behavior of the system for the purpose of improving its performance. The effectiveness of the model depends on the solution obtained from a model and the validity of the model in representing the real systems.

OR Models can be classified according to the following characteristics:

- Classification by structure
  i) Iconic Model: It represents the systems as it is by scaling it up or down. In other words, it is an image.
  ii) Analogue Models: In which one set of properties are used to represent another set of properties.
  iii) Symbolic Models: It is a mathematical model in which the variables are related together by means of mathematical equation or set of equations to describe the behavior of the problem.
- Classification by Purpose
  Models can be classified by purpose of its utility. The purpose of a model may be descriptive, predictive or prescriptive.
- Classification by Nature of Environment, mainly two types i.e., deterministic and probabilistic models.
- Classification by Behaviour are of two types namely static and dynamic models.

- Classification by Method of Solution are of Analytical and simulation models.
- Classification by use of Computers.

The above various OR models can be solved by using the following three methods.

i) Analytic Method
ii) Iterative Method
iii) The Monte-Carlo Method

PHASES OF OPERATIONS RESEARCH STUDY

An OR project can be split in the following seven phases:

Phase 1: **Formulate the problem**. Before proceeding to find the solution of a problem, first of all one must be able to formulate the problem in the form of an appropriate model. The OR analyst first defines the organization's problem. This includes specifying the organization's objectives and the parts of the organization (or system) that must be studied before the problem can be solved.

Phase 2: Observe the problem, the OR scientist collects data to estimate the values of the parameters that affect the organization's problem. These estimates are used to develop (in Step 3) and to evaluate (in Step 4) a mathematical model of the organization's problem.

Phase 3: Constructing a Mathematical Model. The OR personnel develops an idealized representation — i.e. a mathematical model — of the problem.

Phase 4: Testing the model and its solution. Verify the model and use it for prediction The OR analyst tries to determine if the mathematical model developed in Step 3 is an accurate representation of the reality. The verification typically includes observing the system to check if the parameters are correct. If the model does not represent the reality well enough then the OR analyst goes back either to Step 3 or Step 2.

Phase 5: Select a suitable alternative given a model and a set of alternatives, the analyst now chooses the alternative that best meets the organization's objectives. Sometimes there are many best alternatives, in which case the OR analyst should present them all to the organization's decision-makers, or ask for more objectives or restrictions.

Phase 6: Present the results and conclusions. The OR analyst presents the model and recommendations from Step 5 to the organization's decision makers. At this point the OR analyst may find that the decision makers do not approve of the recommendations. This may result from incorrect definition of the organization's problems or decision-makers may disagree with the parameters or the mathematical model. The OR analyst goes back to Step 1, Step 2, or Step 3, depending on where the disagreement lies.

Phase 7:Implementing the solution. Implement and evaluate recommendation finally, when theorganization has accepted the study, the OR analyst helps in implementingthe recommendations. The system must be constantly monitored and updated dynamically as the environment changes.

USES OF OPERATIONS RESEARCH

The Operations Research has successfully entered into many different areas of research like military, government and industry. There is a large scope for economists, statisticians, management administrators, politicians and technicians working in various organizations to solve complex type problems by an OR approach. The Operations Research has tremendous importance in the following fields:

- **In Agriculture.** Determining best policies in the problems of optimum allocation of land to various crops and optimum distribution of resources etc., under the prescribed restrictions.
- **In Finance.** OR techniques can be applied to maximize per capita income with minimum resources and to find out maximum profit and minimize the loss plan for the company etc.
- **In Industry.** The OR techniques are very much useful for the Industry managers in determining optimum allocation of various limited resources like men, machines, material, money, time etc., to arrive at best decision.

- **In Marketing.** The OR techniques are having wide range of applications in marketing such as to distribute the products for sale so that the total cost of transportation is minimum, to minimize the per unit sale price, to select the best advertize media in minimum cost etc.
- **In Personnel Management.** A personnel manager can use OR techniques in appointing suitable persons on minimum salary, to determine the best of age of retirement for the employees, to find out the number of personnel to be appointed when the workload is not continuous.
- **In Production Management.** The production manager of a Industry utilizes the OR methods to find out the optimum quantity to be manufacture per day, in calculating the optimum product mix and in determining the sequence of allocation of items for the production on various machines.

Finally, we can say: whatever there is a problem, there is OR.

ILLUSTRATION: PRODUCTION ALLOCATION PROBLEM.

- **Problem.** A manufacturer of Furniture makes two products: Chairs and Tables. Processing of these two products is done on two machines A and B. Each chair requires 2 hrs on machine A and 6 hrs on machine B where as each table requires 5 hrs on machine A and no time on machine B. There are 16 hrs per day available on machine A and 30 hrs on machine B. Profit gained by manufacturer from chair and table is Rs. 1 and Rs. 5 respectively. What should be daily production of each of the two products so that the total profit in a day is maximum?
- **Mathematical Formulation of the problem.** The above problem mathematically can be expressed as a linear programming problem (LPP) as shown below:
  Maximize the profit $Z = X + 5Y$
  Subject to constraints,
  $2X + 5Y \leq 16$ (Machine A time restriction)
  $6X \leq 30$ (Machine B time restriction)
  and finally $X, Y \geq 0$
  where the variables X and Y represent the number of units of chair and tables to be manufactured in a day.
- **Optimum solution.** The optimum solution to the above production allocation problem on applying the OR technique such as Simplex method is maximum overall profit is Z = Rs. 16 with X = 3.2 tables and Y = 0 Chairs.

CONCLUSION

This paper elaborates about the history of operations research. Also discussed about the classification of models, different phases and its wide range of applications in different spheres. Finally, an illustration related to production allocation problem is considered and its optimum solution is obtained by the method of operations research method such as simplex method.

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