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A STUDY ON PRINCIPLES AND APPLICATIONS OF OPERATION RESEARCH

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ABSTRACT

This chapter will provide an overview of Operations Research (O.R.) from the perspective of an industrial engineer. This chapter focuses on the basic philosophy of O.R. and the so-called "O.R. approach" to solving design and operational problems commonly encountered by industrial engineers. In its most basic form, O.R. may be viewed as a scientific approach to solving problems; it abstracts the essential elements of the problem into a *model*, which is then analysed to yield an optimal solution for implementation. The mathematical details and the specific techniques used to build and analyse these models can be quite sophisticated and are addressed elsewhere in this guide; the emphasis of this chapter is on access. A brief overview of the historical beginnings of O.R. a detailed description of its methodology follows. The chapter concludes with several examples of successful real-world applications of O.R.

Key words: Operations Research, operational problems, scientific approach

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

DEFINITION OF OPERATION RESEARCH

Though there are various definitions of Operation Research which maybe differ as per the perspective of each researcher, I would like to define as an 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.

It can also be defined as 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 for studying the current or future problems. Thus, Operation Research offers alternative plans for a problem to the management for decisions.

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

(i) The environment:

Environment involves physical, social and economic 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. Objectives mean the overall outcome of the formulation that is being expected.

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.

TECHNIQUES OF OPERATION RESEARCH

Important techniques of Operation Research are being described hereunder:

- **Linear Programming**

This is a constrained optimization technique, which optimize some criterion within some constraints. In Linear programming the objective function (profit, loss or return on investment) and constraints are linear. There are different methods available to solve linear programming.

- **Non-linear Programming**

This is used when the objective function and the constraints are not linear in nature. Linear relationships may be applied to approximate non-linear constraints but limited to some range, because approximation becomes poorer as the range is extended. Thus, the non-linear programming is used to determine the approximation in which a solution lies and then the solution is obtained using linear methods.

- **Allocation models**

Allocation models are used to allocate resources to activities in such a way that some measure of effectiveness is optimized .mathematical programming is the board term for the OR techniques used to solve allocation problems. if the measure of effectiveness such as profit, cost,etc.,is represented as a linear function of several variables and if limitations on resources(constrains)can be expressed as a system of linear equalities or inequalities, the allocation problem is classified as a linear programming problem

- **Inventory models**

Inventory model deal with the problem of determination of how much to order at a point in time and when to place an order . the main objective is to minimize the sum of three conflicting inventory costs. The cost of holding or transporting additional inventory, the cost of not having or delaying the delivery of items when needed, and the cost of ordering or setup . These are also useful in dealing with quantity discounts and selective inventory control.

- **Waiting line (or) queuing models**

The models have been developed to establish a trade-off between costs of providing service and the waiting time of a customer in the queuing system. Constricting a model entails describing the components of the system Arrival process, Queue structure and service process and solving for the measure of performance average length of waiting time average time spent by the customer in the line ,traffic intensity etc., of the waiting line.

- **Competitive (game theory) models**

These models are used to characterize the behaviour of two or more opponents (called players)who complete for the achievement of conflicting goals .these models are classified according to several factors such as number of competitors, sum of loss and gain and the type of strategy which would yield the best or the worst outcomes.

- **Network models**

These models are applied to the management (planning, controlling and scheduling) of large scale projects. PERT/CPM techniques help in identifying potential trouble spots in a project through the identification of the critical path. These techniques improve project coordination and enable the efficient use of resources. Network methods are also used to determine time cost trade off resource allocation and help in updating activity time.

- **Sequencing models**

The sequencing problem arises whenever there is a problem in determining the sequence (order) in which a number of takes can be performed by a number of service facilities such As hospital,plant,etc.,in such a way that some measure of performance, for example, total Time to process all the jobs on all the machines, is optimized.

- **Replacement models**

The models are used when one must decide the optimal time to replace an equipment for one reason or the other for instance in the case of the equipment whose efficiency deteriorates with time or fails immediately and completely. For example, in case of an automobile, the user has his own measure of effectiveness. So there will not be one single optimal answer for everyone ever if each automobile gives exactly the same service.

- **Dynamic programming models**

Dynamic programming may be considered as an outgrowth of mathematical programming involving the optimization of multistage (sequence of interrelated decisions)decision processes. The method starts by dividing a given problem in to stages or sub problems and then solves sub problems sequentially until the solution to the original problem is obtained.

- **Markov chain models**

These models are used for analysing a system which changes over a period of time among various possible outcomes or states. The model, while dealing with such systems, describes transitions in terms transition probabilities of various states. These models have been used to test brand loyalty and brand switching tendencies of consumers, where each system state is considered to be a particular brand purchase.

- **Simulation models**

These models are used to develop a method for evaluating the merit of alternative course of action by experimenting with a mathematical model of the problems where various variables are random. That is, these provide a means for generating representative samples of the measures of performance variables. Thus, repetition of the process by using the simulation model provides an indication of the merit of alternative course of action with respect to the decision variables.

- **Decision analysis models**

These model deals with the selection of an optimal course of action given the possible payoffs and their associated probabilities of occurrence. These models are broadly applied to problems involving decision making under risk and uncertainty.

APPICATIONS OF OPERATION RESEARCH

Finance and accounting

(i) dividend polices investment and portfolio management and auditing sheet and cash flow analysis

(ii) claim and complaint procedure and public accounting

(iii) break even analysis ,capital budgeting, cost allocation and control and financial planning

(iv) Establishing costs for by products and developing stranded costs

Marketing

(I) Selection of product mix ,marketing and export planning

(II) Sales effort allocation and assignment

(III) Launching a new product at the best possible time

(IV) Advertising, media planning ,selection and effective packing alternatives

(V) Predicting customer loyalty

Purchasing, procurement and Exploration

(i) Optimal buying and reordering with or without price quantity discount

(ii) Transportation planning

(iii) Replacement policies

(iv) Bidding policies

(v) Transportation planning

(vi) Vendor analysis

Production management facilities planning

(i) Logistics, layout and engineering design

(ii) Transportation, planning , scheduling

Manufacturing

(i) Aggregate production planning, assembly line, blending, purchasing and inventory control

(ii) Employment ,training, layoffs and quality control

(iii) Allocating R&D budgets most effectively

Maintenance and project scheduling

(i) Maintenance policies and preventive maintenance

(ii) Maintenance crew size and scheduling

(iii) Project scheduling and allocation of resources

Personal management

(i) Manpower planning , salary administration

(ii) Designing organization structures more effectively

(iii) Negotiation in a bargaining situation

(iv) Skills and wages balancing

(v) Scheduling of training programmer to maximize skill development and retention

Techniques and general management

(i) Decision support systems and MIS forecasting

(ii) Making quality control more effective

(iii) Project management and strategic planning

Government

(i) Economic planning, natural resources ,social planning and energy

(ii) Urban and housing problems

(iii) Military, police, pollution control, etc

LIMITATIONS OF OPERATIONS RESEARCH

Apart from being a powerful tool which is used for extracting the best out of any finite resource, operations research also has few shortcomings. These limitations only show in the form of time and funds during the formulation of a satisfactory mathematical model. Therefore, the problematic area of its application is just its utility. Few of its highlighted limitations are described below.

1.Complex computation

In case of complex computations of a large number of problems, it is very difficult for a mathematical model to consider every factor of real-life problems and formulate solutions accordingly. Due to this reason, the help of computers is required to calculate the developing relationships between larger variables. This aspect is considered as a discouraging factor by small firm and corporations who wish to acquire the best operations research techniques.

2.Quantity of issues

There are certain intangible factors like as human relationship, human emotions, a decision based on these and so on, which can affect the identification of problems. The perfect solution cannot be found out if these intangible components are removed from the problems. This is because few of these variables are more important than the tangible ones.

3.Difficulty in conceptualization and utilization by managers

The application of operations researches stated as a job which can be executed only by skilled professionals. These experts may be statisticians or mathematicians who have adept understanding and knowledge to formulate models, search for an effective solution and the correct suggestion for its execution. Managers of an organization do not have any concept of the application of operations research technique. If they suggest any OR technique themselves, the probability of lesser comprehension regarding the problem is maximum. This perception may also create an adverse situation for the management who may not recognize the 'why' of that suggestion. The result can lead to a gap which may not be ideal for any organization.

ADVANTAGES OF A GOOD MODEL

(i) A model provides logical and systematic approach to the problem.
(ii) It provides the analyst a base for understanding the problem and think of methods of solving.
(iii) The model will avoid the duplication work in solving the problem.
(iv) Models fix the limitation and scope of an activity.
(v) Models help the analyst to find newer ways of solving the problem.
(vi) Models saves resources like money, time etc.
(vii) Model helps analyst to make complexities of a real environment simple.
(viii) Risk of tampering the real object is reduced, when a model of the real system is subjected to Experimental analysis.
(ix) Models provide distilled economic descriptions and explanations of the operation of the system they represent.

CONCLUSION

The rising complexity of the business scenarios and increased competition leads organisations to take better and quicker decisions. Operation Research is an excellent and a must have tool for every organisation to take an environmentally and economically sound decision pertaining to the current scenario.

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