SVKM'S NMIMS
Deemed to be UNIVERSITY

ANIL SURENDRA MODI SCHOOL OF COMMERCE

"HOWOPERATIONS RESEARCH IS APPLIED IN INDUSTRY/BUSINESS"

SUBMITTED TO

Ms.Tahereem Bardi

SUBMITTED BY

Jason Lobo	A021	74021016370
Kavish Mehta	A022	74021016412
Keshav Holani	A023	74021016254
Leo Soni	A024	74021016583
Mahir Bajaj	A025	74021016064

ON

4th of October 2017

Marks   **Signature**

1. ABSTRACT

Operations Research is the method of analysis and research by which management receives aid for their decisions. Operation Research involves application of the principles and the methods of science to strategize a way to deal with the problems that an industry/business faces.

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 central objective of operations research is optimization, i.e., "to do things best under the given circumstances." This general concept has great many applications, for instance, in agricultural planning, biotechnology, data analysis, distribution of goods and resources, emergency and rescue operations, engineering systems design, environmental management, financial planning, health care management, inventory control, manpower and resource allocation, manufacturing of goods, military operations, production process control, risk management, sequencing and scheduling of tasks, telecommunications, and traffic control.

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.

This paper highlights the relevance, themes, and methodological approaches in context to Operations Research in Business and Industry.

TABLE OF CONTENTS

- ➢ Classification of Models
- ➢ Characteristics of a Good Model
- ➢ Constructing the Model
- ➢ General form of a Mathematical Model
- ➢ Simplification

- ➢ Inventory Control Models
- ➢ Waiting Line Models
- ➢ Replacement Models
- ➢ Allocation Models
- ➢ Competitive Strategies
- ➢ Linear Programming Technique
- ➢ Sequencing Models
- ➢ Simulation Models
- ➢ Network Models

2. INTRODUCTION

Operations Research (OR) is a science which deals with problem, formulation, solutions and finally appropriate decision making. This subject is new and started after World War II, when the failures of missions were very high. Scientists and technocrats formed team to study the problem arising out of difficult situations and at the later stage solutions to these problems. It is research designed to determine most efficient way to do something new. OR is the use of mathematical models, statistics and algorithm to aid in decision-making. Decision making is the main activity of an engineer/manager and Operations research helps us formulate and execute the plan and decisions. With the growth of technology, we also see a growth in organizations, both in size and complexity. An extremely important part of this had been the division of labor and segmentation of management responsibilities. Increasing specialization has created a new problem to meet out organizational challenges which are the allocation of limited resources to various activities which has gained significant importance in the competitive market. These types of problems can be tackled using OR.

The tools of operations research are not from any one discipline, rather Mathematics, Statistics, Economics, Engineering, Psychology, etc. have contributed to this newer discipline of knowledge.

Today, it has become a professional discipline that deals with the application of scientific methods for decision-making, and especially to the allocation of scarce resources.

With the development of PC's the use of OR techniques became prominent and effective tool as large amount of computation is required to handle complex problems.

After the organized development of Operation Research, we see number successful cases in the fields of military, government, commercial banking and industry. Developing countries, mainly in Asia and Africa have the main objective of poverty removal and hunger reduction as swiftly as possible. We see a very expansionary scope for statisticians, economist, administrators, technicians and politicians who work collectively to solve the problem with the help of an O.R. approach.

Operation Research is useful in management of operations. This can be defined as management of systems for providing the goods and services, and continuing with the design and operation of systems for manufacture, transport, supply and service. The operating systems convert the inputs into outputs thus leading to satisfaction of customer needs.

The main concern is the optimum utilization of resources i.e. effective usefulness of the resources or maximum use with minimum loss or wastage. Inputs required for an operating system are raw material, machine and human resource.

The Operations research is performed by team of scientists and experts.

For example - If there is a problem related to the inventory management the organization needs an engineer, accountant and mathematician with a statistician. While in case of major problems the number of people required will be doubled in the organization with other professionals.

3. OPERATIONS RESEARCH ANALYSIS

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

1. **Finance, Budgeting and Investment**

   It helps to maintain a record for the cash flows of the company along with long range of capital requirement, investment portfolios and dividend policies. It also helps to form the credit policies and the claim procedures.

2. **Marketing**

   OR can help to analyse the product selection and the competitive actions like "How many salesmen are required for the organisation, number or the frequency of calling" etc. It helps to formulate all the advertisement strategies with respect to cost and time.

3. **Purchasing**

   OR solves the problem of creating the buying policies of the company and varying its prices of the products. It determines of quantities and timing of purchases, bidding policies, replacement policies of the company.

4. **Production Management**

   It can let us know location and size of warehouses, distribution centres and retail outlets. Distribution policies. It schedules production and sequencing stabilisation of production, employment, layoffs and optimum product mix. It helps to allocate of resources.

5. **Personnel Management**

   OR helps to keep people of mixed ages and recruiting policies and the job assignments.

6. **Research and Development**

   It helps to evaluate reliability and alternate decisions and find the areas of concentration for R&D and determining of time-cost trade off and control of development projects.

4. PHASES IN OPERATION RESEARCH STUDY

The Operation Research Study can be divided into three phases and each phase has a significant impact in the formulation of a business' or industry's decisions and policies which will help it optimize its operations.

The phases are -

1. The Judgement Phase

First and foremost the business has to identify which operation specifically do they have to optimize and what are the details related to the particular operation. They even have to take into consideration the objectives and goals the company is pursuing and aims to achieve.
Then they have to determine the problem, its origin and its causes.

2. The Research Phase

This phase involves observation of the operation selected and collecting primary data for better understanding of the problem being faced. This is followed by the formulation of the operation research model to be used and a hypothesis. Then the hypothesis is verified with the analysis of the primary data formerly collected. Finally this model is tried in production and the results are studied for consideration of alternatives, if required.

3. The Action Phase

Recommendations for remedial action for the problem posed, this includes the assumptions made, scope and limitations, alternative courses of action and their impact on the business. After all the above have been verified the solution derived from the study is put to work and implemented at all levels of the operation.

Many industries follow these phases in full even if they are not using Operation Research but they end up leaving the important steps out. Only judgement and subjective decision-making are not good enough. Thus industries use operation research for a better and more objective way to make decisions. These methods should also use the emotional and subjective factors which differ from business to business.

5. OPERATION RESEARCH METHODOLOGY

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

1. **Formulating the Problem**

   Economics of an operation must be considered in formulating a problem for OR. Study analysis should also be done of the following major components:

   - **The environment.**
   - **The objectives.**
   - **The decision maker.**
   - **The alternative courses of actionand constraints**

2. **Constructing a Model to Represent the System under Study**

   After acquiring the approval of the project/model by the management, the next step is to construct a model for the system or operation under study. The operation researcher can now formulate the ORmodel to show the interrelations between a cause and an effect or between an action and a reaction. The operation researcher aims to develop a model which enables him to predict the effect of variables important to the solution of given problem. The model proposed can be tested and modified in order to adjust to the stated environmental constraints. Modifications maybe made in the model if the management is not happy with its performance.

3. **Deriving Solution from the Model**

   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.

4. **Testing the Model and the Solution Derived from it**

   As has been pointed out earlier a model is never a perfect representation of reality. An accurately formulated and properly manipulated model is very useful to forecastthe effect of changes in variables on the increase

in system effectiveness. The validity and credibility of the model is verified by comparing the results with the data obtained without using the model.

5. 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.

6. Implementation of the Solution

The final step of the operation research methodology is implementation of solutions obtained in the previous steps. In operation research though decision making is scientific and objective but its implementation involves so many behavioural issues and other subjective factors. Therefore the implementing authority has to resolve the behavioural issues. He has make his subordinates as well as his superiors understand the idea of the utility of OR.

The non-cooperation between O.R experts and the management may create hurdles and problems thus the gap between the solution provider and the solution implementer must be eliminated. To achieve this both the management and O.R scientist should play a positive role. A proper model derived through application of OR techniques results in better working conditions and boost the morale of the management.

6. OPERATION RESEARCH MODELS

Operation Research model is an optimal reflection of the real life situation and represents multiple aspects of reality. Some examples of operation research models are: a map, activity charts balance sheets, PERT network, etc. The primary goal of the model is to act as a basis for assessing the behaviour of the system to make it more efficient.

A. Classification of Models

Models can be classified on the basis of following factors

1. By degree of Abstraction:
- Mathematical models.
- Language models.

2. By Function:
- Descriptive models.
- Predictive models.
- Normative models for repetitive problems.

3. By Structure:
- Physical models.
- Analogue (graphical) models.
- Symbolic or mathematical models.

4. By Nature of Environment:
- Deterministic models.
- Probabilistic models.

5. By the Time Horizon:
- Static models.
- Dynamic models.

B. Characteristics of a Good Mode

- Assumptions should be simple and minimal.
- Variables should be as less as possible.
- It should be able to incorporate the system environmental changes without causing any change in its framework.
- It should be easy to construct.

C. Constructing the Model:

A mathematical model is an array of equations in which the details of the system are explained. The equations denote various objective functions and constraints. Objective function can be defined as a mathematical expression of objectives (cost or profit of the operation), while constraints are mathematical expressions of the limitations on the completion of the objectives.

These expressions consist of a mixture of controllable and uncontrollable variables.

D. 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.

As model is simply an estimate of the real situation, hence it may not contain all the variables.

E. Simplification in Operation Research Models:

While the model is being constructed, efforts should be made to simplify the model, however, only to an extent where accuracy is not being compromised on.

F. Some of the Common Simplifications Are:

- Omitting certain variables.
- Aggregating (or grouping) variables.
- Changing the nature of variables e.g., considering variables as constant or continuous.
- Changing relationship between variables i.e., considering them as linear or straight line.
- Modify constraints.

7. TECHNIQUES

Important techniques of Operation Research are being described hereunder:

1. **Inventory Control Model**

   It involves balancing inventory cost like storage, ordering or interest cost. This study helps in taking decisions like how much to purchase, when to order or manufacture or make purchase decision. Most well-known use is the Economic Order Quantity (EOQ).

2. **Waiting Line Model**

   The model used to reduce the waiting time or the idle time is known as Waiting Line Model.

   This model is of two types:

       (a) Queuing theory is used to determine service facility and time of internal for services.

       (b) Sequencing theory is used determine the sequence of the services.

3. **Replacement Model**

   This model is used for calculating the time taken for maintenance or repair or replacement of any item because of obsolesce or inefficiency or beyond economical to repair or maintenance.

4. **Allocation Model**

   When there is a situation where there a number of activities that can be performed and various alternative ways of doing them, this model is used. This model is also used when there are limited resources which do not allow each activity to be performed in its best possible way.

5. **Competitive Strategies**

   These strategies are taken up when efficiency of one agency's decision is dependent on another agency's decision.

6. 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.

7. Sequencing Model

It is the selection of an appropriate order in which a number of jobs can be assigned to a finite number of service equipment or machines so as to optimize the outputs in terms of time, cost or profit.

8. Simulation Model

Experimental model used to study behavior over time is known as stimulation model.

9. Network Model

The network model is a database model conceived as a flexible way of representing objects and their relationships. Its distinguishing feature is that the schema, viewed as a graph in which object types are nodes and relationship types are arcs, is not restricted to being a hierarchy or lattice.

8. APPLICATIONS OF OPERATION RESEARCH

1. Transportation or Distribution problems

There are various centers with various demands and various warehouse with different supply thus by linear programming techniques, we can find the best distribution channel.

2. Product mix

This model is used to find the best product mix to get maximum profit or minimum cost.

3. Assignment of Personnel

This model is used to assign different jobs to different candidates with different aptitude to get the least time for the assignment.

4. Production Planning

These techniques can be used to assign multiple jobs to different machines so as to get maximum profits or to fully utilize production capability or reduce total time taken.

5. Agricultural production

We can use these to increase farmer's profit, involving cultivation a number of items with various different outputs and growth time in separate types of lands having variable fertility.

6. Financial application

The LPP technique helps solve various different financial problems ranging from portfolio management for maximize investment return from the different available opportunities all the way to deciding the financial mix strategies.

9. LIMITATIONS

1. Quality and emotional factors are not taken in account.

2. Applicable to specific areas like decision making problems.

3. Wrong interpretation can be misleading.

4. Due to already set outlooks in the way of processing and dealing with information any form of change leads to a certain amount of backlash or for lack of better words resistance from employees/workers and in a few incidents even the employer.

5. Models regarded only for reality and not for obsolete techniques.

10. CONCLUSION

The main fields where OR is extensively used are given below, however, this list is not exhaustive but only illustrative. This list defines the scope of OR and how it is extensively used in the industries today.

1. **National Planning and Budgeting**

    OR is mainly used for the preparation of the five-year plan of the government, annual budgets, income forecasting and expenditure forecasting, timely scheduling of major projects of national importance, estimation of the GNP, GDP, employment, population, birth rate and death rate plus the generation of agriculture yields.

2. **Defence Services**

    The formulation of O.R. started from the U.S Army thus it has wide application in the areas such as: development of new technology, optimum utilisation of cost and time, tender evaluation, setting and layouts of defence projects, assessment of threat analysis, strategy of battle, effective maintenance and replacement of the equipment, transportation and supply depots and inventory control.

3. **Industrial Establishment and Private Sector Units**

    OR can be used in plant location and setting the finance planning which means managing the money in the organisation, product and process planning, facility planning and construction, production planning and control, purchasing, maintenance of management and managing the people in the organisation.

4. **R & D and Engineering**

    Research and development is considered as the heart of technology growth. It has been seen that OR has wide scope for and it can be applied in forecasting and evaluation, technology and project management. Preparing the tender, how much money is to be required for works, negotiating of work, work method and time study.

5. **Business management and Competition**

OR can help in taking business decisions under risk and uncertainty, capital investment and returns, business strategy i.e. making plans for the business, optimum advertisement outlay, minimum sales force and their distribution, market survey and various research techniques.

6. **Agriculture and irrigation**

OR is found to be useful for managing the project, construction of dams using the least resources, allocating the seeds and fertilisers in the optimum way for the better yield and crop.

7. **Education and Training**

OR can be used for obtaining optimum number of schools in a particular location, how many teachers and students can be accommodated correctly in these, optimum financial outlay, and information related to training of the graduates.

8. **Transportation**

OR can be used to solve real life problems such as forecasting of number of public transport required, optimum routing, budgeting of income and expenditure, project of railways and railway network distribution.

9. **Home Management and Budgeting**

OR can be used in utilisation of the savings, appropriate insurance of life and properties, time management, work study, home science and estimation of depreciation of assets.

Thus we can see from the above examples the growing use of Operation Research in today's world and how readily the industries are adopting new strategies to optimize their production costs.

APPENDIX

[1]. http://www.universalteacherpublications.com/univ/ebooks/or/Ch1/phases.htm

[2]. http://www.newagepublishers.com/samplechapter/001948.pdf

[3]. http://www.yourarticlelibrary.com/ergonomics/operation-research/operation-research-applications-methodology-and-tools/90745/

[4]. http://www.businessmanagementideas.com/personnel-management/operation-research/operation-research-definition-scope-and-techniques/6556

[5]. http://mathworld.wolfram.com/OperationsResearch.html

REFERENCE

[1]. http://www.pitt.edu/~jrclass/or/or-intro.html

[2]. Leachman, R. C., R. F. Benson, C. Liu and D. J. Raar, "IMPReSS: An Automated Production-Planning and Delivery-Quotation System at Harris Corporation - Semiconductor Sector," Interfaces, 26:1, pp. 6-37, 1996.

[3]. Rigby, B., L. S. Lasdon and A. D. Waren, "The Evolution of Texaco's Blending Systems: From OMEGA to StarBlend," Interfaces, 25:5, pp. 64-83, 1995.

[4]. Flanders, S. W. and W. J. Davis, "Scheduling a Flexible Manufacturing System with Tooling Constraints: An Actual Case Study," Interfaces, 25:2, pp. 42-54, 1995.

[5]. Subramanian, R., R. P. Scheff, Jr., J. D. Quillinan, D. S. Wiper and R. E. Marsten, "Coldstart: Fleet Assignment at Delta Air Lines,", Interfaces, 24:1, pp. 104-120, 1994.

[6]. Kotha, S. K., M. P. Barnum and D. A. Bowen, "KeyCorp Service Excellence Management System," Interfaces, 26:1, pp. 54-74, 1996.