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As per Dr. A.P.J. Abdul Kalam Technical University Syllabus
MBA
2nd
Semester

Quantitative Techniques in Management

Dr. Saroj Kumar
Pravesh Kumar Singh

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QUANTITATIVE TECHNIQUES IN MANAGEMENT

MBA, SEMESTER - II

According to the new syllabus of 'Dr. A.P.J. Abdul Kalam Technical University', Lucknow

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"Dedicated

to

Almighty God

&

*my **Family"***

-***Dr. Saroj Kumar***

"Dedicated

to

*my **Family"***

- Pravesh Kumar Singh

Preface

We feel very happy in bringing this book **Quantitative Techniques in Management** for the students of MBA Second Semester of the **Dr. A.P.J. Abdul Kalam Technical University**. This book is specially designed to cover the syllabus of AKTU.

This book results from a long-standing classroom notes for the postgraduate courses offering Operations Research. We have taken a lot of efforts to make the subject more interesting by arranging the units logically. Many examples have been included to illustrate, clarify and supplement the methods. We are sure that students using this book will be able to acquire knowledge in quantitative concepts very quickly. The questions are set from the recent examinations of the University. The language used has been very simple.

The salient features of this book are:

- The text has been written in a very simple and clear language.
- The text has been presented in an interesting way to enhance reading experience.

While writing the book, we referred many books on the subject and we are grateful to all those authors for the influence. Utmost care has been taken to present the book in an effective manner but all valuable suggestions are welcome for the improvement.

We hope both the students and teachers will be able to use this book effectively. We are expecting valuable suggestions for improvements from our dear students and lecturers, which will be useful for our next edition.

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Website, **www.tppl.org.in**

Acknowledgement

Writing a book is like a single activity but it requires the cooperation and commitment of many individuals involved directly or indirectly. The success in every work-output is directly related to the effectiveness of the team, and our whole team played an important role. We know that it would be very difficult to mention all those names but we would like to make an honest attempt.

We are indebted to our **Gurus** who gave us so much knowledge and support throughout our life and today by their blessings we are able to write this book.

We owe a deep sense of gratitude towards the Crew members of **Thakur Publication Pvt. Ltd**. especially to **Mr. Dileep Singh** (Sr. Executive Editor), and **Mr. Saumitra Veer Singh** whose ungrudging and everlasting help has made it possible to shape the endeavour in a right direction.

We are also thankful to **Our Parents** for their constant support and encouragement. Last but not the least, we would like to thank the **Almighty God**, for giving us this privilege and opportunity to share our knowledge with others.

-Dr. Saroj Kumar

-Pravesh Kumar Singh

Syllabus

Quantitative Techniques in Management

KMB 206

Course Objectives

To make better decisions in complex scenarios by the application of a set of advanced analytical methods. It couples theories, results and theorems of mathematics, statistics and probability with its own theories and algorithms for problem solving.

Course Credit: 3 **Contact Hours: 36 Hrs**

UNIT I **(4 Sessions)**

Operations Research Introduction :- Introduction, Historical Background, Scope of Operations Research Phases of Operations Research, Types of Operations Research Models, Limitations of Operations Research

UNIT II **(10 Sessions)**

Linear Programming Problem & Transportation Problem Linear programming: Mathematical Formulations of LP Models for Product-Mix Problems; Graphical and Simplex Method of Solving LP Problems; Duality.

Transportation Problem: Various Methods of Finding Initial Basic Feasible Solution-North West Corner Method, Least Cost Method & VAM Method and Optimal Solution-Stepping Stone & MODI Method, Maximization Transportation Problem

UNIT III **(10 Sessions)**

Assignment Model & Game Theory Assignment model: Hungarian Algorithm and its applications, Maximization Assignment Problem.

Game Theory: Concept of game; Two-person zero-sum game; Pure and Mixed Strategy Games; Saddle Point; Odds Method; Dominance Method and Graphical Method for solving Mixed Strategy Game.

UNIT IV **(10 Sessions)**

Sequencing & Queuing Theory Sequencing Problem: Johnsons Algorithm for n Jobs and Two Machines, n Jobs and Three Machines, Two jobs and m - Machines Problems.

Queuing Theory: Characteristics of M/M/I Queue Model; Application of Poisson and Exponential Distribution in Estimating Arrival Rate and Service Rate; Applications of Queue Model for Better Service to the Customers.

UNIT V **(6 Sessions)**

Replacement Problem & Project Management Replacement Problem: Replacement of Assets that Deteriorate With Time, Replacement of Assets Which Fail Suddenly. Project Management: Rules for Drawing the Network Diagram, Applications of CPM and PERT Techniques in Project Planning and Control; Crashing of Operations.

Contents

Unit 1: Introduction to Operations Research

Unit 2: Linear Programming Problem & Transportation Problem

Unit 3: Assignment Model and Game Theory

Unit 4: Sequencing & Queuing Theory

Unit 5: Replacement Problem & Project Management

UNIT 1

Introduction to Operations Research

Learning Objectives:

This unit provides an overview of Operations Research. After studying this unit one should be able to:

- Understand the scope of Operations Research.
- Explain the uses of Operations Research.
- Know the application of Operations Research in Business.
- Understand the models of Operations Research.
- Understand the Phases of Operations Research.
- Understand the Operations Research Techniques.

1.1. OPERATIONS RESEARCH

1.1.1. Introduction

Operations Research (OR) is a discipline that deals with the application of advanced analytical methods to help in make better and improved decision. It is a systematic study of basic structure, characteristics, functions and relationships of an organisation, and provides a basis to managers for improved decision-making.

OR takes a scientific approach to best decide, how to design and operate man-machine systems, for industrial use. In other words, OR deals with optimal resource allocation. Most of the actual work is done using analytical and numerical techniques that helps to develop and manipulate mathematical models of organisational systems.

Operations research is also known as **Decision Science** or **Quantitative Techniques.** Unlike many other disciplines, that focuses on technology, OR is an interdisciplinary mathematical study that focuses on the effective use of technology by organisations.

Operations Research arrives at optimal or near-optimal solutions to complex decision-making problems, by employing techniques like mathematical modelling, statistical analysis, and mathematical optimisation.

According to Operations Research Society, America, "Operation research is concerned with scientifically deciding, how to best design and operate man machine systems; usually requiring the allocation of scarce resources".

According to T.L. Saaty, "Operation research is the art of giving bad answers to problems to which otherwise worse answers are given".

According to P.M. Morse and G.E. Kimball, "Operation research is a scientific method of providing executive departments with a quantitative basis for decision under their control ".

According to H.M. Wagner, "Operation research is a scientific approach to problems solving for executive management".

According to Miller and Starr, "Operations research is applied decision theory. It uses any scientific, mathematical, or logical means to attempt to cope with the problems that confront the executive when he tries to achieve a thorough going rationality in dealing with his decision problems".

According to E.L Arnoff and M. J. Netzorg, "Operations research is the systematic, method-oriented study of the basis structure, characteristics,

functions and relationships of an organisation to provide the executive with a sourd, scientific and quantitative basis for decision-making"

Operational Research, or simply OR, originated in the context of military operations, but today it is widely accepted as a **powerful tool** for planning and decision-making, especially in business and industry. The OR approach has provided a new tool for managing conventional management problems. In fact, operational research techniques do constitute a scientific methodology of analysing the problems of the business world. They provide an improved basis for taking management decisions. The practice of OR helps in tackling intricate and complex problems such as that of resource allocation, product mix, inventory management, sequencing and scheduling, replacement, and a host of similar problems of modern business and industry.

With IT facilities becoming widely available, the significance and scope of OR has grown, and is still growing. Hence, OR is now an integral part of courses of computer science, economics, business management, public administration and several other disciplines. An operation research (OR) is an **analytical method** of problem-solving and decision-making that is useful in the management of organizations. In operations research, problems are broken down into basic components and then solved in defined steps by mathematical analysis.

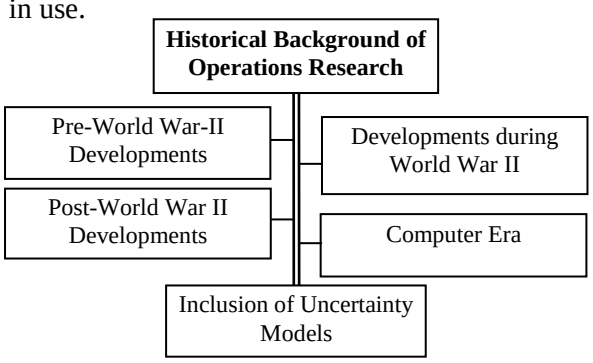
Analytical methods used in OR include mathematical logic, simulation, network analysis, queuing theory, and game theory. The process can be broadly broken down into three steps:

1) A set of potential solutions to a problem is developed.
2) The alternatives derived in the first step are analysed and reduced to a small set of solutions most likely to prove workable.
3) The alternatives derived in the second step are subjected to simulated implementation and, if possible, tested out in real-world situations. In this final step, psychology and management science often play important roles.

1.1.2. Historical Background of Operation Research(OR)

The operation research's origin and growth is explained through following hierarchy:

1) **Pre-World War-II Developments:** Before introduction of the 'operations research', various other techniques such as inventory control, queuing theory and statistical quality control of the operations research were developed and were in use.



A simple Economic Order Quality (EOQ) model was developed which is used in optimising the total cost of the inventory system. EOQ was first developed by **Ford Harris** in 1915 and was finally evaluated in 1934 by **R.H. Wilson**.

In same year, a Danish telephone engineer named **A.K. Erlang** developed new theoretical concepts of the queuing theory.

In early 1900s, Western Electric's Bell Laboratory's inspection engineering department analysed the problem occurred in the routine quality checks. This led to the development of the control charts in 1924 by **Shewhart** and was named as Shewhart control charts.

Many terminologies related to the acceptance sampling of quality control were described by Western Electric Company in the time period of 1925-26. The attributes of raw materials/components/finished products were controlled using these terminologies.

The developed terminologies were like consumer's risk, producer's risk, probability of acceptance, Operating Characteristics (OC) curve, Lot Tolerance Percent Defective (LTPD), double sampling plan, type-I error, type-II error and many more. The fundamental concept of sampling inspection was introduced in 1925 by **Dodge** and after a decade, the British Standard Institution Number 600 was developed by **Pearson** with title 'Application of statistical methods to international standardisation and quality control'.

2) **Developments during World War II:** At the time of World War II, the Britain military was mainly concerned for the effective exploitation of infrequent resources. Hence, a research was conducted by the native scientists. They

discovered the various ways to make the fullest use of the resources to improve the efficiency of the military operations. This approach was incorporated in operations research methodologies for problem-solving aspects.

3) **Post-World War II Developments:** Post Second World War, the main emphasis of the American and British companies was to maximise the profit from limited resources, so, these companies focused on application of operation research methodologies. The simplex method, for solving linear programming problem, was developed by **Dantzing** in 1947. Thereafter, in 1950, Operations Research Society of America and in 1953, the Institute of Management Sciences was established.

4) **Computer Era:** There were various complex computations in the operations research which consumed much time; hence, the computers were developed to solve such problems easily. The development of the recent interactive computers established a new milestone in the large size problems solving. The reason for this is that person involved towards sensitivity analysis of problems.

5) **Inclusion of Uncertainty Models:** The operations research techniques were more shaped with the use of the probability theory and statistics.

1.1.3. Characteristics of Operations Research

Some significant characteristics of Operations Research are highlighted below:

1) **Decision-Making:** Decision-making or problem solving constitutes the major working of operations research. Managerial decision-making is considered to be a general systematic process of operations research (OR).

2) **Scientific Approach:** Like any other research, operations research also emphasises on the overall approach and takes into account all the significant effects of the system. It understands and evaluates them as a whole. It takes a scientific approach towards reasoning. It involves the methods defining the problem, its formulation, testing and analysing of the results obtained.

3) **Objective-Oriented Approach:** Operations Research not only takes the overall view of the problem, but also endeavours to arrive at the best possible (say optimal) solution to the problem in hand. It takes an objective-oriented approach. To achieve this, it is necessary to have a defined measure of effectiveness which is based on the goals of the organisation. This measure is then used to make a comparison between alternative solutions to the problem and adopt the best one.

4) **Inter-Disciplinary Approach:** No approach can be effective, if applied individually. OR is also inter-disciplinary in nature. Problems are multi-dimensional and approach needs a team work.

   For example, managerial problems are affected by economic, sociological, biological, psychological, physical and engineering aspect. A team that plans to arrive at a solution, to such a problem, needs people who are specialists in areas such as mathematics, engineering, economics, statistics, management, etc.

1.1.4. Role of OR in Decision Making

In managerial decision-making, the management chooses a specific course of action, from a set of possible options, when face a problem. The manager tries to choose the most effective course of action in the given circumstances keeping the targets of the organisation in mind.

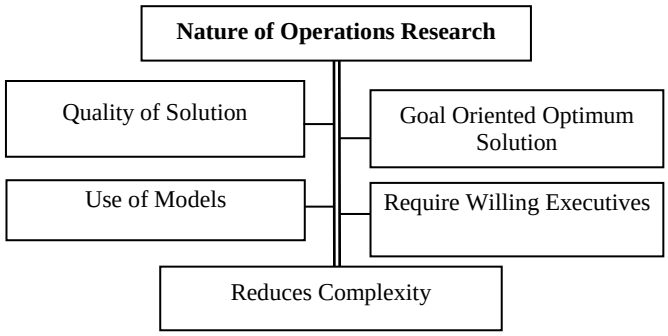
Some decision-making situations are simple in real life. Complexities in decision-making situations arise due to several factors. These factors include the interaction of the economic, political, technological, environmental and competitive forces in society in a complicated manner, the limited resources of an organisation, the values, the risk attitudes and the knowledge of the decision-makers.

For example, the factors such as market conditions, labour rates and its availability, investment requirements and availability of funds, influence a company's decision to introduce a new product. The decision for production methodology, cost and quality of the product, price, package design, marketing and advertising strategy will be of multidimensional response. Every segment of the organisation will be affected conceivably by such decisions.

The major roles of Operations Research in decision making are as below:

1) It provides a tool for scientific analysis.
2) It offers solutions for various business problems
3) It enables proper deployment of resources.
4) It supports in minimising waiting and servicing costs.
5) It helps the management to decide when to buy and what is the procedure of buying.
6) It helps in reducing the total processing time necessary for performing a set of jobs.

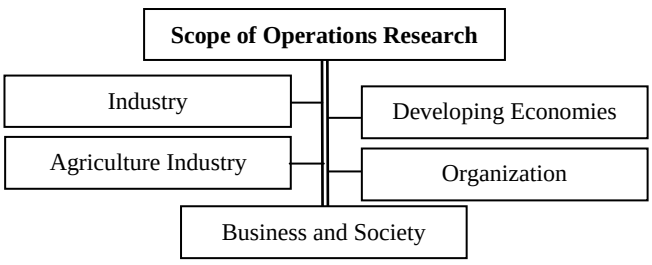
1.1.5. Nature of Operations Research



1) **Quality of Solution:** Operation research simply helps in improving the quality of the solution but does not result into a perfect solution.
2) **Goal Oriented Optimum Solution:** Operations Research tries to optimize a well-defined function subject to given constraints and as such is concerned with the optimization theory.
3) **Use of Models:** Operations Research uses models built by quantitative measurement of the variables concerning a given problem and also derives a solution from the model using one or more of the diversified solution techniques. A solution may be extracted from a model either by conducting experiments on it or by mathematical analysis. The purpose is to help the management to determine its policy and actions scientifically.
4) **Require Willing Executives:** Operations Research does require the willingness on the part of the executive for experimentation to evaluate the costs and the consequences of the alternative solutions of the problem. It enables the decision-maker to be objective in choosing an alternative from among many possible alternatives.
5) **Reduces Complexity:** Operations Research tries to reduce the complexity of business operations and does help the executive in correcting a difficult function and to consider innovations which are too costly and complicated to experiment with the actual practice.

1.1.6. Scope of Operations Research

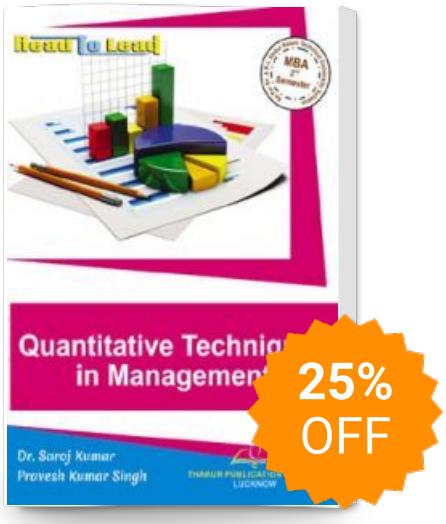
Operation Research can be applied to different areas of business such as:



1) **Industry:** Industrial management deals with a series of problems, starting right from the purchase of raw materials till the dispatch of final products. The management is ultimately interested in overall understanding of the methods, of optimising profits. Therefore, to take decision on scientific basis, operations research team has to think about various alternative methods, to produce goods and obtaining returns in each case.

   Not only this, the operations research study should also suggest possible changes in the overall structure like installation of a new machine or introduction to automation, etc., for optimising the results. Many industries have gained immensely by applying operations research in various tasks. **For example,** operations research can be used in the fields of manufacturing and production, blending and product mix, inventory management, for forecasting demand, sale and purchase, for repair and maintenance jobs, for scheduling and sequencing planning, and also for scheduling and control of projects.
2) **Developing Economies:** OR is applicable to both developing and developed economies. But a lot of scope exists in developing economies, for building up an operations research approach towards planning. The basic idea is to orient the planning, to achieve maximum growth per capita income in minimum time; considering the goals and restrictions of the country. Poverty and hunger are the core problems faced by many countries of Asia and Africa. Therefore, people like statisticians, economists, technicians, administrators, politicians and agriculture experts can work in conjunction, to solve this problem with an operations research approach.
3) **Agriculture Industry:** Operations research approach has a huge scope in agriculture sector. Population explosion has led to scarcity of food. Optimum allocation of land for various crops in accordance with climatic conditions is a challenge for many countries. Also, each developing country is facing the problem of optimal distribution of water from several water bodies. These areas of concern hold a great scope for scientific research.
4) **Organisation:** Organisation, big or small, can adopt operations research approach effectively. Operational productivity of organisations have improved by using quantitative techniques. Techniques of operations research, can be applied to minimise cost, and maximise benefit

Quantitative Techniques In Management



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