OPERATIONS RESEARCH - CONTEMPORARY ROLE IN MANAGERIAL DECISION MAKING

Dr.Vijay Kumar, Associate Professor,

Department of Mathematics,

P.G Centre, College of Commerce, Arts and Science, Patna

ABSTRACT:

Operations Research (OR) is a field of study that employs mathematical models, statistical analysis, and optimization techniques to aid decision-making processes in organizations. OR has been used extensively in various fields, including manufacturing, transportation, healthcare, finance, and logistics, to name a few. In recent years, OR has gained immense popularity in managerial decision-making processes due to its ability to provide effective and efficient solutions to complex problems. OR has helped organizations streamline their operations, reduce costs, and improve their bottom line by identifying bottlenecks, reducing wastage, and improving resource allocation. The contemporary role of OR in managerial decision-making has become increasingly important due to the complexity of modern business environments, where organizations face numerous challenges, such as globalization, technological advancements, and changing consumer preferences.

Keywords: Operations Research, Contemporary, Managerial, Decision Making

1. INTRODUCTION:

Operations Research (OR) is widely used in the nonprofit and public sectors as a tool for administrative decision science. World-class manufacturing systems (WCM), lean production, six sigma quality management, benchmarking, and just-in-time (JIT) inventory strategies are just a few of the areas where Operations Research is becoming more important as the global economy becomes increasingly competitive. Competition in global marketplaces has intensified with their expansion, highlighting the need for Operational Research. With the ultimate objective of being competitive in today's global economy, businesses must provide clients with high-quality products and services at fair prices. To get your money's worth, you need something that combines simplicity, amazement, speed, and reliability in its data. To improve operational research and speed up the process of diverse partners, they need to collaborate closely and reinforce each other's efforts. Academics should take the lead in this effort by developing and presenting convincing operational research models. Business should help boost this effort and speed up the transmission. For the short and long term, this would ensure the creation of wealth. The government should support this effort by welcoming enhanced responses. As a result, favorable shifts in the societal and monetary environment would be realized via the use of optimum policy responses. Therefore, the administration, businesses, and the public at large would routinely incorporate managed utilization of operational research into their decision making processes. If more people in government, industry, and academia in India used operational research methods, it would improve governance and the standard of living there. This study is an effort to draw attention to the value of operation research, the methods it employs, and the ways in which it has been put to use in the commercial and industrial sectors.[1]

Operations Research (OR) is a scientific and quantitative approach to solving complex decision-making problems that are commonly encountered by organizations. OR is an interdisciplinary field that employs mathematical, statistical, and computer modeling techniques to optimize the performance of systems, processes, and operations. The roots of OR can be traced back to World War II, where it played a crucial role in military logistics and planning. Today, OR has emerged as a powerful tool for managerial decision making, and its applications are found in various industries such as finance, healthcare, transportation, and manufacturing.

we will explore the contemporary role of OR in managerial decision making, focusing on its key concepts, methods, and applications. We will also discuss the challenges and limitations of OR and its future prospects.

1.1 Key Concepts of Operations Research

OR is based on the principle of optimization, which involves finding the best solution among all possible alternatives, given a set of constraints. OR models are typically formulated as mathematical programming problems, where an objective function is optimized subject to constraints. The objective function represents the measure of performance or the goal of the system, while the constraints represent the limitations or restrictions that must be satisfied.[2]

OR models can be classified into two broad categories: deterministic and stochastic. Deterministic models assume that all parameters are known with certainty, while stochastic models account for uncertainty and randomness in the system. Stochastic models are particularly useful in situations where the future outcomes cannot be predicted with certainty, such as in financial markets or healthcare.

Another important concept in OR is simulation, which involves constructing a computer model of a system and running it under different scenarios to evaluate its performance. Simulation is useful in situations where the system is too complex or costly to analyze analytically.

1.2 Applications of Operations Research

OR has a wide range of applications in various industries, including finance, healthcare, transportation, and manufacturing. Some of the most common applications are:

i. Finance

OR is widely used in finance for portfolio optimization, risk management, and option pricing. OR models can help investors to construct a portfolio that maximizes returns while minimizing risks.

ii. Healthcare

OR is used in healthcare for resource allocation, patient scheduling, and medical decision making. OR models can help hospitals to optimize their resources and improve patient outcomes.

iii. Transportation

OR is used in transportation for route planning, vehicle scheduling, and logistics management. OR models can help transportation companies to reduce costs and improve efficiency.

iv. Manufacturing

OR is used in manufacturing for production planning, inventory control, and quality management. OR models can help manufacturers to optimize their processes and improve product quality.[3]

2. EVOLUTION OF OPERATION RESEARCH AS AN ACADEMIC DISCIPLINE

As a result of this heritage, operational research is currently widely used in government agencies for productive resource planning and allocation, as well as in protection research institutes. Companies subsidized actual and projected applications, which contributed to the rapid expansion of this order. Over time, the control was developed and expanded to everyone's benefit thanks to cooperative efforts between the government, business, and academic communities. The past half-century has seen operational research expand into a truly interdisciplinary field, including not only finance but also mathematics, insights, mechanical design, and management. As a whole, operational research may be broken down into three major groups. Combining models, creating a more efficient distribution network, and optimizing an asset portfolio are all excellent examples of models. Project management software, multi-criterion optimization, the game theory, the reproduction method, the information envelopment analysis, the frameworks for organizing project assets, and techniques for resolving conflicts are all part of an operational research strategy. There is a wide range of contexts in which operational research's tools, models, and methods have proven useful. In a similar vein, a few of exceptional scholars have aided in the growth of this field.[4]

3. OPERATIONS RESEARCH APPROACH

The ability to apply O.R. to a general issue depends on a firm grasp of the framework it represents, which O.R. expresses as an integrated set of tools for making choices. The so-called O.R. strategy for doing this is outlined here. The following are the seven stages of this method: Initiation, Defining the Problem, Gathering Data, Formulating the Model, Solving the Problem, Testing the Model, Analyzing the Results, Deploying the Model, and Checking Its Performance.

The following Flow Diagram shows this:

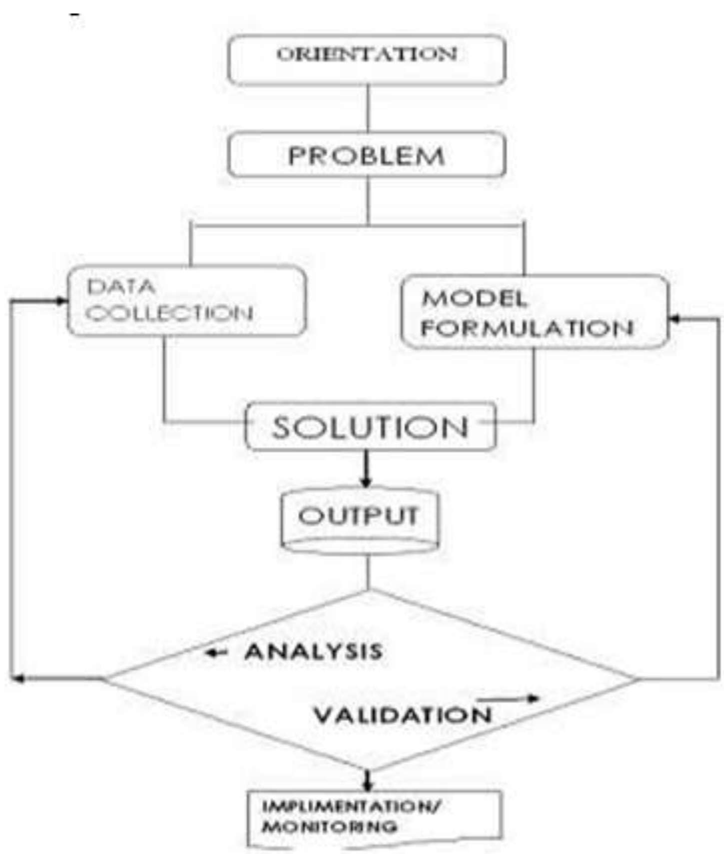

Figure 1: Operations research approach

Consider the usual scenario of an assembly company scheduling production for the next month to see how the methods may be related. To create its many products, the company draws on a wide range of resources, including human labor, industrial machinery, raw materials, financial backing, data analytics, warehouse space, and inventory management tools. The items generate different total revenues and call for dissimilar asset valuations. Some of the resources can only be accessed by approved personnel. Other complicating factors include things like fluctuating demand for the products, unscheduled maintenance on the machines, and union agreements that place limits on the productive use of the workforce. As an example of how one may steer an operations research study to solve this situation, think of a very simplified scenario of a generation arranging problem where there are just two core products. The company incurs varying expenditures (for labor, raw materials, etc.) and realizes varying profits (from sales) for each product it manufactures and sells. The objective of the O.R. project is to divide the available resources as fairly as possible between the two final goods.[5]

3. METHODS OF OPERATIONS RESEARCH

Linear programming: emerged as a result of a mathematical model created during World War II for maximizing profits while minimizing losses sustained by the armed forces. Optimization in Operational Research is the process of identifying the conditions under which a given transaction would provide the greatest possible gain while incurring the smallest possible loss using quantitative methods, allowing us to focus on the optimal solutions among what would otherwise be an infinite number of alternatives. This method optimizes a criteria within a set of restrictions; hence, it is called a "constrained optimization" method. Linear programming has a linear goal function and limitations (such as a fixed cost or desired rate of return on investment).

This mathematical technique is used to optimize linear functions subject to linear constraints. The basic formula for linear programming is:

Maximize (or Minimize) $Z = c1x1 + c2x2 + ... + cnxn$

Subject to: $a11x1 + a12x2 + ... + a1nxn <= b1$

a21x1 + a22x2 + ... + a2nxn <= b2 ...

am1x1 + am2x2 + ... + amnxn <= bm x1, x2, ..., xn >= 0

Here, c1, c2, ..., cn are the coefficients of the objective function, a11, a12, ..., amn are the coefficients of the constraint equations, b1, b2, ..., bm are the constraint values, and x1, x2, ..., xn are the decision variables.

Integer Programming: The decision variables in integer programming can only take on whole numbers, unlike in traditional linear programming. Production planning and scheduling are two examples of applications where integer programming is helpful since the decision variables reflect discrete alternatives.

Nonlinear Programming: Nonlinear programming is a mathematical optimization technique that is used to find the optimal solution to a nonlinear objective function subject to nonlinear constraints. Nonlinear programming is particularly useful in situations where the objective function or the constraints are nonlinear.

To optimize a nonlinear objective function under nonlinear constraints is the focus of Nonlinear Programming (NLP), a subfield of optimization theory. A Nonlinear Programming issue may be stated in its most basic form as:

Minimize f(x)

Subject to:

g_i(x) ≤ 0, i = 1, 2, ..., m

h_j(x) = 0, j = 1, 2, ..., p

where x = (x1, x2, ..., xn) is the vector of decision variables, f(x) is the nonlinear objective function to be minimized, g_i(x) ≤ 0 are the inequality constraints, and h_j(x) = 0 are the equality constraints.

Finding the values of the decision variable x that minimize the objective function f(x) according to the constraints is the key to solving a Nonlinear Programming issue. However, analytical solutions are often not possible due to the nonlinear nature of the problem, necessitating the use of numerical methods.

Nonlinear programming problems may be solved numerically using a wide variety of techniques, including gradient-based approaches like the steepest descent and Newton methods, and heuristic techniques like simulated annealing and evolutionary algorithms.

Partial derivatives and gradients are calculated to determine the best choices for the decision variables during optimization of the objective function and constraints. Depending on the nature of the issue and the optimization technique being used, a number of different mathematical methods may be utilized to compute these derivatives and gradients. The following formula, for instance, may be used to determine the gradient of the objective function:

$$\nabla f(x) = (\partial f/\partial x1, \partial f/\partial x2, ..., \partial f/\partial xn)$$

where $\partial f/\partial xi$ is the partial derivative of the objective function with respect to the ith decision variable.

It is also possible to use the chain rule of differentiation to determine the partial derivatives of the restrictions. Handling equality and inequality requirements is also possible using the Lagrange multipliers approach.

Dynamic Programming: Dynamic programming is a mathematical technique that is used to solve problems that can be divided into smaller subproblems. Dynamic programming is particularly useful in situations where the optimal solution depends on the previous decisions.

Monte Carlo Simulation: Monte Carlo simulation is a statistical technique that is used to evaluate the performance of a system under different scenarios. Monte Carlo simulation involves generating random numbers from a probability distribution and using them to simulate the system.[6]

Queueing theory: Mathematical queuing theory is used to the study of lines of people waiting for something. Queueing theory's fundamental formula is:

$L = \lambda W$ where L is the typical number of users, is the typical rate of new users, and W is the typical amount of time a user spends using the system.

Decision tree analysis: This mathematical method is used in the study of choice under hazard. Decision tree analysis may be reduced to a simple formula:

Expected value = (Probability of outcome 1 x Value of outcome 1) + (Probability of outcome 2 x Value of outcome 2) + ... + (Probability of outcome n x Value of outcome n)

4. DECISION ANALYSIS IN OPERATIONS RESEARCH

Analytical and mathematical methods are used in the field of operations research known as "decision analysis" to assess difficult choices. Decision analysis is a useful tool for determining the best course of action given a set of given circumstances and a set of given facts.

There are four main phases to a decision analysis: identifying the issue, creating a model, brainstorming potential solutions, and evaluating those options. The decision issue is formulated at this stage, with goals, options, and constraints specified. A computational or mathematical model of the decision issue is built at the model development stage. The model is used to assess and compare potential solutions throughout the solution generating phase. The analysis of the solution involves taking the data and deciding what it means.

Decision trees are widely used as a tool for decision analysis. A decision tree is a graphical depiction of a problem with several possible solutions, each with its own set of outcomes and probability. When assessing a choice issue with several outcomes and unknowns, decision trees may be useful tools.

Multi-criteria decision analysis (MCDA) is another valuable tool for making sense of different options. In MCDA, many factors are considered simultaneously to determine the best course of action. In order to make the best choice possible, decision-makers may use MCDA to take into account a variety of criteria and information.[7]

4.1 Applications of Decision Analysis in Operations Research

Decision analysis has many applications in operations research, including:

Resource Allocation: Decision analysis can be used to optimize the allocation of resources in a variety of industries, including healthcare, transportation, and finance. Decision analysis can help decision makers to determine the optimal allocation of resources based on available data and constraints.

Risk Management: Decision analysis can be used to evaluate and manage risks in a variety of industries, including finance, insurance, and engineering. Decision analysis can help decision makers to evaluate the potential consequences of different risks and to identify the best strategies for managing them.[8]

Product Development: Decision analysis can be used to evaluate different product development strategies, including product design, pricing, and marketing. Decision analysis can help decision makers to identify the optimal product development strategy based on available data and market conditions.

Environmental Management: Decision analysis can be used to evaluate different environmental management strategies, including pollution control, resource conservation, and sustainable development. Decision analysis can help decision makers to identify the optimal environmental management strategy based on available data and environmental objectives.

4.2 Advantages of Decision Analysis in Operations Research

Some of the advantages of using decision analysis in operations research include:

Data-driven Decision Making: Decision analysis helps decision makers to make informed decisions based on available data and information. This can lead to more effective and efficient decision making.[9]

Improved Risk Management: Decision analysis can help decision makers to identify and manage risks more effectively, reducing the likelihood of negative consequences.

Consideration of Multiple Objectives: Decision analysis can help decision makers to consider multiple objectives or criteria when making a decision, leading to more balanced and optimal decisions.

Better Resource Allocation: Decision analysis can help decision makers to allocate resources more efficiently, leading to better utilization of resources and improved outcomes.

5. ROLE OF COMPUTERS IN SOLVING OPERATION RESEARCH PROBLEMS

Time-consuming and laborious calculations characterize Operation Research issues. Indeed, it takes quite some time to solve even a simple problem with a couple of variables by hand or with a hand calculator. The widespread application of Operation Research methods to the resolution of complex business challenges faced by managers and executives in industry and government has been hastened by the advent of computers. Because computational calculation is now automated, leaders can concentrate on defining problems and clarifying their solutions. In order to provide computational support for issues to be addressed using Operational Research approaches, major computer makers and merchants have developed software packages for the various computer systems. Some academic departments at various universities have also developed software suites for addressing a variety of Operation Research issues. Companies in the computer industry such as IBM, CDC, Honeywell, UNIVAC, ICL, and many others have invested heavily in the research and development of software to address issues in the fields of optimization, scheduling, inventory management, simulation, and other areas of Operational Research. Similar to GPSS software packages, computers can do large-scale simulations.[10]

6. GROWTH OF OPERATION RESEARCH IN DIFFERENT SECTORS

Steel, Heavy Engineering, Chemical and Fertilizer, Textile, Transportation & Distribution, and Electronics are just few of the sectors that have benefited from these methods. The phrase "Operations Research" might be deceiving since its focus extends beyond operations to include study in many other disciplines. Operations Research is the study of using cutting-edge analytic techniques to improve decision-making. Operations research equips top-level management with tools for better analysis, decision-making, and system design in order to improve efficiency and output. The importance of operational research in India is unmistakable. Given the sheer scale and scope of the challenges that lie ahead in establishing India as a developed country, this is not only an issue of paramount importance, but one of urgent urgency. A responsible and accessible government is necessary to provide a fertile ground for OR applications and help us reach our objectives. It is hoped that this would happen as a result of India's democratic system. This shift is expected to speed up even more as a result of globalization.[11]

7. CHALLENGES IN OPERATIONS RESEARCH

Optimization issues are difficult and time-consuming to solve because they need extensive amounts of data and computation. This method of boosting productivity has the potential to be cost-effective for certain businesses. Several ongoing research projects aim to enhance existing heuristic and definite calculations to better illuminate large-scale optimization problems. On the other side, quantitative problem-solving techniques emphasize the importance of information in developing workable solutions. An organization that uses an information system, such as MRP or ERP, to make data immediately available should be able to use the necessary data with some degree of integrity. However, the information driven decision science techniques she presented could be the best option for an extremely manual framework. Linear programming, discrete event simulation, and queueing theory will be the most sensible and correct choice tools as more and more businesses transition to centralized information management. The veracity of data is dependent on several factors. Some examples of these factors are information systems that rely on human input for data, unstable networks, risky ventures, and broken machinery. Human error in information contribution is the most crucial aspect in determining high information respectability. Instruction combined with hands-on training, like on-the-job training, may significantly cut down on the number of errors people make. Sadly, many organizations prioritize heavily the deployment of physical systems while giving little thought to training and development. However, employees are frequently blamed for inaccurate data entry, and the reliability of hardware and/or software is discussed as a possible cause. The maintenance of utilization is essential. The most well-known database in the world is of little use to an organization if the people in charge of maintaining and administering the system know nothing about developing and deploying it.[12]

8. FUTURE PROSPECTS OF OPERATIONS RESEARCH

Despite its limitations and challenges, OR has a promising future as a tool for managerial decision making. Advancements in technology and data analytics have opened up new possibilities for OR applications, and the growing importance of data-driven decision making is likely to increase the demand for OR expertise.

One area of particular promise is the integration of OR with artificial intelligence (AI) and machine learning (ML). AI and ML techniques can help to overcome some of the limitations of OR models, particularly in areas with high levels of uncertainty and complexity. The combination of OR and AI/ML has the potential to transform decision making in many industries.[13]

Another area of potential growth is the development of OR solutions for sustainability and social responsibility. OR can be used to optimize processes and systems in ways that minimize environmental impact and promote social welfare. As sustainability and social responsibility become increasingly important for organizations, the demand for OR solutions in these areas is likely to grow.

9. CONCLUSION:

In conclusion, Operations Research (OR) plays a crucial role in modern managerial decision-making processes by providing effective and efficient solutions to complex problems. OR has proven to be a valuable tool for organizations across various industries, including manufacturing, transportation, healthcare, finance, and logistics. The contemporary role of OR has become increasingly important due to the growing complexity of modern business environments, where organizations face numerous challenges. OR has helped organizations streamline their operations, reduce costs, and improve their bottom line by identifying bottlenecks, reducing wastage, and improving resource allocation. OR has been used in healthcare to optimize patient flow, reduce waiting times, and improve resource utilization. In manufacturing, OR has been used to design efficient production processes, reduce downtime, and improve product quality. Furthermore, OR has helped organizations optimize their supply chain management, reduce inventory levels, and improve delivery times.

10. REFERENCES:

1. Adomi E. E. (2018). Pattern of use of the information for decision making by administrative staff of a University in Nigeria. Library Management, 23(7), 330-337
2. Bida, A. M., & Abba, T. (2015). Utilization of information among small scale entrepreneurs (SSEs) in Niger State, Nigeria. International Journal of Academy Library and Information Science, 2 (7), 66-72
3. Ajayi, I. A., & Omirin, F. F. (2017). The use of Management Information Systems (MIS) in decision making in the South West Nigerian Universities. Educational Research and Reviews, 2 (5), 109-116.
4. Bindu Sharma & Sangita Gupta. (2019). Information seeking behaviour of faculty members at Sher-e-Kashmir, University of Agriculture Science and Technology, Jammu, India in internet era: A survey. IASLIC Bulletin, 57 (1), 23-33.
5. Fiankor, D. K., & Akussah, H. (2020). Information use and policy decision making by district assembly members in Ghana. Information Development, 28 (1), 32-42

6. Gill, M. S. (2020). Use of e-journals by medical professionals: A study of Indian Council of Research Libraries in Delhi. Library Herald, 50 (4), 348-352.
7. Couper, M. P. et.al. (2016). Use of internet and ratings of information sources for medical decisions: Results from the DECISIONS survey. Medical Decision Making, 30, 106-114.
8. Al-farajat, A. H., Al-sarayreh, M. N., (2017). Information systems and their role in the performance of the Jordanian tourism companies. Global Journal of Human Social Science, 11 (8), 1-9.
9. Deval, A. K. (2015). Use and assessment of digital information resources: A user's perspective of GGSIP University library. Library Herald, 50 (1), 32-334.
10. Gabriel, J. M.O., & Obara, L. C. (2016). Management information systems and corporate decision making: A literature review. The International Journal of Management. 2 (3), 78-82.
11. Baladhandyutham, A. (2018). A study on the use of online information among the scholars of the School of Biotechnology in Madurai Kamaraj University, Madurai. IASLIC Bulletin, 57 (4), 82-88.
12. Bruns Jr., W., & Mc Kinnon, S. (2019). Information and managers: A field study. Journal of Management Accounting Research, 5, 84-108.
13. Gayatri, M. (2019). Information needs of scientists and engineers in electronic environment: A case study of Indian exploratory and production industry. Annals of Library and Information Studies, 53(4), 173-183.