

Notes on Operation Research in Business

B.Com 6th Semester (Major)

What is Operation Research?

Ans: Operations Research (OR) is a field concerned with using method to improve our decision-making processes. It uses different mathematics statistical models, and techniques to uncover the patterns and tendencies Operations Research can be described as offering a structured and ever mathematical decision-making model, which is essential in today's world where data controls everything. Operations Research was born during World War II when military commanders and other leaders tried to develop scientific solutions that would enhance the general communication. transport and planning processes in their military strategies. Today, it has emerged as an important tool in various fields, such as the industry at large, commerce, engineering, health care, and civil services, for efficiency and economic improvement. Operations research is the appropriate way of setting up and solving a problem to acquire the best solution for mathematics.

2. Write briefly the Limitations and Challenges of operational research.

Ans: Limitations and Challenges of operational research are:

- (i) Reliance on accurate data: The quality of OR outputs is directly dependent on the accuracy of the input data. Flawed, incomplete, or outdated information can lead to incorrect conclusions and suboptimal decisions.
- (ii) High costs and computational demands: Advanced OR techniques can require specialized software, significant computational power, and expert staff, making it a costly investment. This can be prohibitive for smaller businesses.
- (iii) Difficulty modeling non-quantifiable factors: OR excels at quantitative analysis but struggles to account for qualitative factors like employee morale, customer satisfaction, or corporate culture. The models simplify reality and may not capture every aspect of a business problem.
- (iv) Implementation and resistance to change: Getting organizational buy-in for OR solutions can be challenging. Employees and managers may resist changing long-standing procedures based on mathematical models, especially if they do not fully understand the process or fear job displacement.
- (v) Bridging the gap between analyst and manager: A communication and understanding gap can exist between technical OR analysts and business managers. Analysts may not fully grasp the practical business context, while managers may find the complex mathematical models difficult to interpret.

3. Write briefly the benefits/ importance of Operation research.

Ans: Benefits of operations research are:

- (i) Optimization: Finds the best solutions for complex problems. Leading to more efficient resource allocation, production scheduling, and inventory management to minimize costs and maximize productivity.
- (ii) Improved Decision-Making: Provides decision-makers with data-driven, quantitative tools and models to support choices in uncertain environments, leading to better and more informed decisions.
- (iii) Reduced Uncertainty: By using proven methods and models with realistic data, operations research can help eliminate or reduce uncertainty, making complex processes easier to manage.
- (iv) Enhanced Efficiency: Improves productivity and coordination between different departments and teams, leading to smoother operations and a more streamlined work flow.
- (v) Detailed Analysis: Provides a more in-depth and comprehensive analysis of problems by using analytical, mathematical, and scientific methods.
- (vi) Risk Management: Helps in assessing and managing risks by simulating potential outcomes of different decisions, allowing businesses to identify and mitigate potential negative impacts.

4. Write briefly the Nature of Operations Research.

Ans: Operations research is characterized by its scientific and systematic approach to problem-solving. Unlike traditional decision-making processes that may be based on experience or intuition, operations research relies on quantitative analysis and logical reasoning

Some key aspects that define the nature of operations research include:

- (i) Goal-Oriented Approach: Operations research focuses on finding the most effective solution to a given problem by either maximizing or minimizing specific objectives, such as increasing profits, reducing costs, or improving time efficiency.
- (ii) Interdisciplinary Framework: It draws knowledge from multiple fields, including mathematics, economics, engineering, computer science, and strategic management, allowing for a comprehensive and well-rounded problem-solving approach.
- (iii) Data-Driven Analysis: It relies extensively on data collection, statistical evaluation, and numerical modeling to ensure informed and accurate decision-making.

(iv) Optimization-Centric Methodology: The primary objective of operations research is to enhance efficiency by identifying the best way to allocate resources, streamline processes, and achieve optimal performance.

(v) Experimental and Model-Based Approach: OR involves developing mathematical models and conducting simulations to test different strategies, assess their feasibility, and refine solutions before applying them in real-world scenarios.

5. Describe the Evolution of Operations Research.

Ans: Operations Research has its roots in as early as the first half of the 20th century. It is the process that took place in the course and after the Second World War.

Here is a chronological overview:

(i) Early Beginnings: Operations Research can be traced back to its roots in the early 20th century, and it had its share of management gurus, such as Frederick Taylor, whose work delayed the application of scientific principles in management.

(ii) World War II: Operations Research found its way mainly during the Second World War, where its most important advances emerged. Military operations required optimization of resource use and thus created operational research teams that involved mathematicians, scientists, and engineers, which further shaped OR.

(iii) Post-War Development: From the war onwards, many techniques were applied to industrial planning, hence the formation of OR societies and journals.

(iv) Technological Advancements: After the introduction of computers in the 1950s and 1960s, the use of OR became more efficient. and it was now possible to solve some of the problems through simulations and optimization.

(v) Modern Day: Today. OR is present in many enterprises and serves as one of the tools for managing decision-making in such sectors as logistics. SCM. finance, health care, etc. The upcoming and current advancement of big data and analytics in OR further increases its range of uses and fields of practice.

6. Discuss in details the History of Operations Research.

Ans: Operation Research is a relatively new discipline. Whereas 70 years ago it would have been possible to study mathematics, physics or engineering (for example) at university it would not have been possible to study Operation Research, indeed the term O.R. did not exist then. It was really only in the late 1930's that operational research began in a systematic fashion, and it started in the UK. As such it would be interesting to give a short history of O.R.

(i) 1936: Early in 1936 the British Air Ministry established Bawdsey Research Station, on the east coast, near Felixstowe, Suffolk, as the centre where all pre-war radar experiments for both the Air Force and the Army would be carried out. Experimental radar equipment was brought up to a high state of reliability and ranges of over 100 miles on aircraft were obtained. It was also in 1936 that Royal Air Force (RAF) Fighter Command, charged specifically with the air defense of

Britain, was first created. It lacked however any effective fighter aircraft - no Hurricanes or Spitfires had come into service - and no radar data was yet fed into its very elementary warning and control system. It had become clear that radar would create a whole new series of problems in fighter direction and control so in late 1936 some experiments started at Biggin Hill in Kent into the effective use of such data. This early work, attempting to integrate radar data with ground based observer data for fighter interception, was the start of OR.

(ii) 1937: The first of three major pre-war air-defence exercises was carried out in the summer of 1937. The experimental radar station at Bawdsey Research Station was brought into operation and the information derived from it was fed into the general air-defense warning and control system. From the early warning point of view this exercise was encouraging, but the tracking information obtained from radar, after filtering and transmission through the control and display network, was not very satisfactory.

(iii) 1938: In July 1938 a second major air-defense exercise was carried out. Four additional radar stations had been installed along the coast and it was hoped that Britain now had an aircraft location and control system greatly improved both in coverage and effectiveness. Not so! The exercise revealed, rather, that a new and serious problem had arisen. This was the need to coordinate and correlate the additional, and often conflicting information received from the additional radar stations. With the outbreak of war apparently imminent, it was obvious that something new - drastic if necessary had to be attempted. Some new approach was needed.

(iv) 1939: In the summer of 1939 Britain held what was to be its last pre-war air defence exercise. It involved some 33,000 men, 1,300 aircraft, 110 anti-aircraft guns, 700 searchlights, and 100 barrage balloons. This exercise showed a great improvement in the operation of the air defence warning and control system. The contribution made by the OR team was so apparent that the Air Officer Commander-in-Chief RAF Fighter Command (Air Chief Marshal Sir Hugh Dowding) requested that, on the outbreak of war, they should be attached to his headquarters at Stanmore in north London. Initially, they were designated the "Stanmore Research Section". In 1941 they were re-designated the "Operational Research Section" when the term was formalized and officially accepted, and similar sections set up at other RAF commands.

(v) 1940: On May 15th 1940, with German forces advancing rapidly in France, Stanmore Research Section was asked to analyse a French request for ten additional fighter squadrons (12 aircraft a squadron - so 120 aircraft in all) when losses were running at some three squadrons every two days (i.e. 36 aircraft every 2 days). They prepared graphs for Winston Churchill (the British Prime Minister of the time), based upon a study of current daily losses and replacement rates, indicating how rapidly such a move would deplete fighter strength. No aircraft were sent and most of those currently in France were recalled. This is held by some to be the most strategic contribution to the course of the war made by OR (as the aircraft and pilots saved were consequently available for the successful air defense of Britain, the Battle of Britain).

(vi) 1941 onward: In 1941, an Operational Research Section (ORS) was established in Coastal Command which was to carry out some of the most well-known OR work in World War II. The responsibility of Coastal Command was, to a large extent, the flying of long-range sorties by single aircraft with the object of sighting and attacking surfaced U-boats (German submarines). The technology of the time meant that (unlike modern day submarines) surfacing was necessary

to recharge batteries, vent the boat of fumes and recharge air tanks. Moreover U-boats were much faster on the surface than underwater as well as being less easily detected by sonar. Thus the Operation Research started just before World War II in Britain with the establishment of teams of scientists to study the strategic and tactical problems involved in military operations. The objective was to find the most effective utilization of limited military resources by the use of quantitative techniques. Following the end of the war OR spread, although it spread in different ways in the UK and USA. In 1951 a committee on Operations Research formed by the National Research Council of USA, and the first book on "Methods of Operations Research", by Morse and Kimball, was published. In 1952 the Operations Research Society of America came into being.

8. Explain the various Scope of Operation Research.

Ans: The scope of Operations Research encompasses various areas which are as given below:

(1) Optimization and Decision Making: Optimization is the main subject of OR, and applications are found almost in every area. It covers optimal price strategies and the minimum usage of resources, allowing the business to make the best possible decision with the available data. The decision-maker balances different constraints such as time, budget, and available resources with the best course of action.

(ii) Mathematical Modeling: Scope of Operation Research is fundamentally integrated into mathematical modeling. From simulating material flow in factories to modeling the movement of goods in a supply line, the mathematical models underlie complex systems such that decision-makers can comprehend them and identify areas for improvement. Businesses can then analyze problems and make predictions about their outcomes.

(iii) Resource Allocation: In resource-constrained environments such as a manufacturing plant or a hospital, scope of operation research techniques are used in an attempt to optimally allocate limited resources, whether that be labor or equipment, or much more simply, materials. OR is then capable of enabling organizations to allocate resources so that output is maximized while waste and other inefficiencies are minimized.

(iv) Simulation and Risk Analysis Scope of Operation Research can also be defined as simulation modeling capable of future outcome prediction for different alternative decisions. Using simulated models similar to the models that existed in real life, one can decide how possible increase or decrease could be evicted from the performance by parameters like demand variation or disruption in the supply chain.

(v) Transportation and Logistics: Planning efficient routes, scheduling vehicles, and optimising supply chains to reduce transportation costs and improve delivery times.

(vi) Production Planning: Determining optimal production schedules. resource allocation, and capacity planning to maximise output and minimise costs.