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Chapter 1: Introduction to Operations Research

Operations research is a relatively new discipline, as the use of operations research dates back to World War II and was then used for military purposes where teams of specialists in mathematics, engineering, economics, statistics, psychology...etc. by studying problems and proposing solutions to them using operations research. Then its use moved to non-military fields to be used in business, government and industry, and the emergence and development of computers contributed to the application of operations research in solving problems in management and industry...etc.

1. Definition of Operations Research:

- ❖ Operations research is a set of quantitative methods that are widely used in the decision-making process.
- ❖ Operations research is a decision-making process based on the scientific method based on quantitative analysis methods in solving problems with the aim of reaching the optimal solution (Optimal Solution) within the limits of available capabilities and resources.
- ❖ Operations research is the building of a practical scientific model that encompasses all aspects of the issue under study and finding the optimal solution that is applied to solve the problem at hand.

2. Reasons for the need for operations research:

- There is a complex problem in which several factors overlap.
- Need for a quantitative explanation of the decision.
- A repetitive problem with different inputs.
- Achieving a competitive advantage for the organization.
- The need to reduce risk when starting a new project.

Reasons for the need for operations research:

There are circumstances and situations that make operations research an indispensable tool:

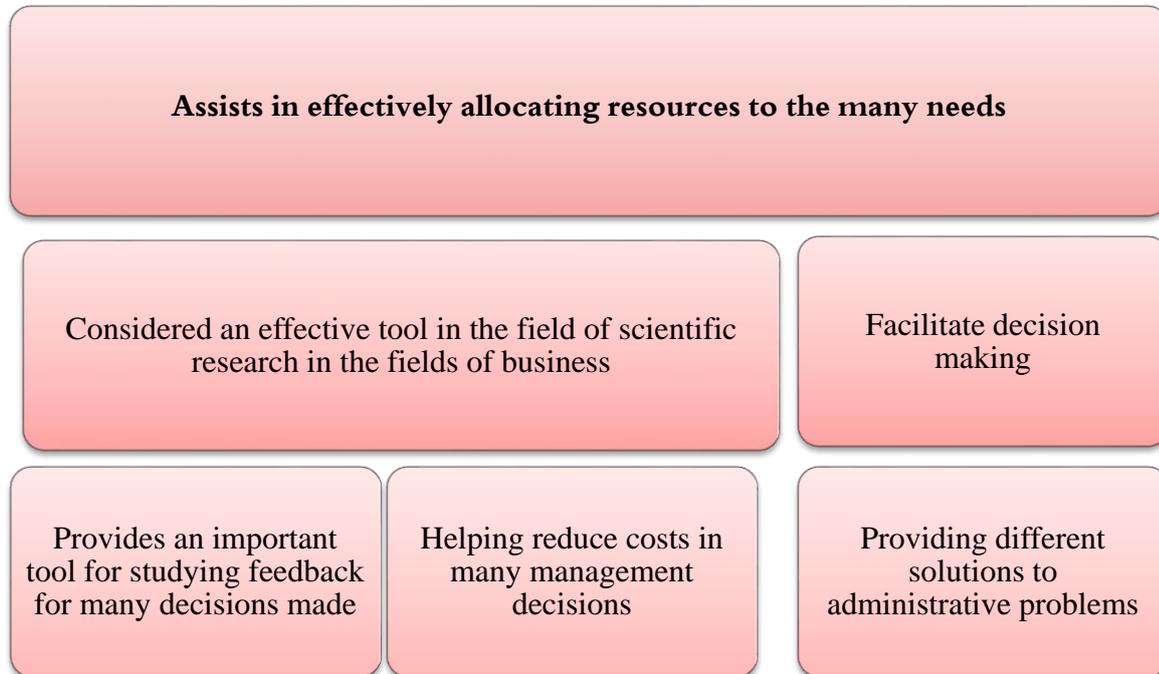
1. The problem can be very complex.
2. The problem may be new and there is no prior experience.
3. The problem may be very frequent.
4. Problem may require quantitative justification.
to reduce risk.
6. To achieve competitive advantage
7. Not benefiting from the data.

3. Importance of Operations Research: The importance of operations research can be summarized as follows:

- An aid in making quantitative decisions using modern scientific methods.
- The science of operations research is one of the scientific means to help make decisions in a more accurate manner and away from randomness resulting from trial and error.
- Operations research is a science, an art and a science at the same time. It relates to the efficient allocation of available resources as well as their new capacity to reflect the concept of efficiency and scarcity in applied mathematical models.
- It helps to address complex problems with analysis and solution that are difficult to address in their normal form.
- It helps to save the cost of solving different problems by reducing the time required to solve.

- It helps to focus attention on the important characteristics of the problem without going into the details of the characteristics that do not affect the decision, and this helps to identify the appropriate elements of the decision and use them to reach the best.

4. Process Research Functions: The main functions of business process research methods can be summarized as follows:



5. Conditions for the application of operations research:

Process research methods can be applied in various production and service institutions, provided that two conditions are met:

- Limited resources:** The resources used by the organization, whether in productive, commercial or other processes, are limited in terms of availability and accessibility, and this applies to: Financial resources, highly qualified and specialized human resources, land with rare specifications as with land where there is oil or coal and gold mines and others...etc.
- Alternative:** This condition means that there is more than one alternative or method by which the available and limited resources are exploited. For example, in the production process for producing men's clothing, if the available limited resources are the men's fabrics used in producing T-shirts and pants, then what is meant by alternatives here is the existence of more than one way to cut the fabric in order to obtain the required products at the lowest possible cost.

Choosing the best or optimal alternative is subject to multiple criteria, the most important of which is that the alternative achieves the highest benefits or the lowest costs and losses (Optimal Solution)

6. Mathematical Models in Operations Research:

Mathematical models are often used to formulate the problem and search for the optimal solution. Examples (optimization) means that process (decision) that helps the organization reach its goals with the highest possible efficiency, such as maximizing profits or the best ways to exploit basic production requirements, or cost, by choosing the best solution. Quantitative analysis is used to help management in the organization make appropriate decisions to clarify the problem to be studied and expressed in numbers and mathematical formulas.

The mathematical models consist of three sections:

Mathematical models components

Objective function:

A mathematical formula that links the decision variables, and expresses the total value of the goal of solving the problem.

Constraints: The determinants of the mathematical model that are necessary to express the limitation of resources in the form of the model.

Decision variables: These are the variables whose values are reached through the solution of the mathematical model, and on the basis of whose values the decision is made

Objective function: The function may represent total profits and take the Maximization formula, and the function may represent total costs and take the Minimization formula in this case.

7. Operations Research Methodology:

The stages of quantitative analysis in operations research include eight basic steps:

- **Step 1: Monitor and formulate the problem environment**

It means monitoring the problem environment, and researching the operation of the organization's resources (human and material) taking into account the problem factors that consist of four basic components: environment, objectives, decision-makers, alternative courses of action and constraints.

- **Step 2: Analyse and define the problem**

This step is to set the objectives and limitations of operations research to define and study the problem

- **Step 3: Formulate and build the model**

The formulation of the model is intended as a representation of the components of the studied problem, the identification of the factors affecting it, the circumstances surrounding it, and the method of linking them.

- **Step 4: Model Solution**

The solution of the model means: finding the set of values of the decision variables through which the possible solution to the studied problem is reached, and then finding the optimal solution from them.

- **Step 5: Test the validity or effectiveness of the model**

Model validity testing means: showing the ability of the model to represent the components of the studied problem.

- **Step 6: Try the Model Solution**

The aim of the model solution experiment is to verify the accuracy of the results obtained from the application of the model and its validity.

- **Step 7: Implement the model solution**

Implementing the model solution means putting the proposed solution into practice and following up on its application, to ensure that the model is valid or not valid, and this means transforming the conceptual model into the operational model in the real and realistic world.

■ Step 8: Model Optimization

The improvement of the model means: the introduction of the necessary amendments in the event that it is proven that the model is needed at the implementation stage, with the aim of achieving the required results from its application in line with the situation of reality.