OPERATIONS RESEARCH

CHAPTER I

INTRODUCTION

Many people still remain in the bondage of self-incurred tutelage. Tutelage is a person's inability to make his/her own decisions. Self-incurred is this tutelage when its cause lies not in lack of reason but in lack of resolution and courage to use it without wishing to have been told what to do by something or somebody else.

The difficulty in life is the choice. Good decision-making brings about a better life. A bad decision may force you to make another one. A good decision is never an accident; it is always the result of high intention, sincere effort, intelligent direction and skillful execution; it represents the wise choice of many alternatives. One must appreciate the difference between a decision and an objective. A good decision is the process of optimally achieving a given objective.

When decision making is too complex or the interests at stake are too important, quite often we do not know or are not sure what to decide. In many instances, we resort to informal decision support techniques such as tossing a coin, asking an oracle, visiting an astrologer, etc. However formal decision support from an expert has many advantages. **Business Science** focuses on the formal model-driven decision support techniques such as mathematical programs for optimization, and decision tree analysis for risky decisions. Such techniques are now part of our everyday life. For example, when a bank must decide whether a given client will obtain credit or not, a technique, called credit scoring, is often used.

Rational decisions are often made unwillingly, perhaps unconsciously. We may start the process of consideration. It

is best to learn the decision-making process for complex, important and critical decisions. Critical decisions are those that cannot and must not be wrong.

The aim of this course is to make you a better decision maker by learning the decision-making process. Decision-making is a complicated process. This complication arises from the fact that your present goal (including wants, resources, and abilities) dictates your choices; however, your choices will change your goals. This influential-cycle keeps the decision-maker busy all the time. Selecting your goals and your criteria for success is a dynamic process and changes over time. The following flowchart depicts the goal as the foundation of decision-making process. This is true in almost all cases dealing with personal growth or organizational growth:

On a daily basis a manager has to make many decisions. Some of these decisions are routine and inconsequential, while others have drastic impacts on the operations of the firm for which he/she works. Some of these decisions could involve large sums of money being gained or lost, or could involve whether or not the firm accomplishes its mission and its goals.

In our increasingly complex world, the tasks of decision-makers are becoming more challenging with each passing day. The decision-maker (i.e., the responsible manager) must respond quickly to events that seem to take place at an ever-increasing pace. In addition, a decision-maker must incorporate a sometimes-bewildering array of choices and consequences into his or her decision. Routine decisions are often made quickly, perhaps unconsciously without the need for a detailed process of consideration. However, for complex, critical or important managerial decisions it is necessary to take time to decide systematically.

To make strategic decisions requires that one takes a structured approach following a formal decision making process. Otherwise, it will be difficult to be sure that one has considered all the key aspects of the decision.

Historical development of OR

It is generally agreed that OR come into existence as a discipline during world war II when there was a critical need to manage scarce resources. However, a particular model and technique of OR can be traced back to much earlier times. The war involved strategic and tactical problems which were greatly complicated to expect adequate solution from individuals or specialists in a single discipline. Therefore groups of individuals who collectively were considered specialists in mathematics, economics, statistics and probability theory, engineering, behavioral and physical science were formed as a special units within the armed forces to deal with strategic and tactical problems of various military operations.

Problems of this latter kind, often called systems problems, were studied rigorously for the first time by scientists, not in industry but in the management of operations in the 1939 - 45 war.

A number of teams of eminent scientists were employed by the British Government to apply their expertise to management and operational problems rather than technical problems.

One such team (the Radar Operational Research team - which gave OR its name) was responsible for implementing the installation and operation of radar after the technical development work was complete.

Later on another team examined the relative ineffectiveness of the Allied Forces at destroying the German U-boats, which were sinking the food convoy ships supplying Britain.

The OR team played an important part in reducing shipping losses and in the ultimate defeat of the U-boats. With no precedent in the application of Science to the management function, the scientists were still able to use their scientific approach-collecting information and developing hypothesis in order to come up with practical plans for the improvement of these wartime operations.

After the end of the war, the same approach was used with great success in the industrial and commercial field, developing most rapidly in Britain and the USA, followed by Europe and the rest of the world. This has provided the basis for the evolution of Operational Research (OR) as a separate and independent subject of Science. It is not based on any single academic engineering, social science, economics, statistics and computing but is none of these. Then what is OR?

There are three different factors behind the rapid development in the use and development of operations research approach.

- The economic and industrial boom after World War II resulted in continuous mechanization, automation, decentralization of operations and decisions of management functions. This industrialization also resulted in complex managerial problems and therefore application of operations research to managerial decision making become popular.
- Many operations researchers continued their research after war. A key person in the post war development of OR was George B. Dantzing. In 1947 he developed the concept of

linear programming and its solution by a method known as simplex method.

- Analytic power was made available by high-speed computers.

DEFINITION

Operations Research is defined by many authors in different ways .However, the following definition is proposed here.

"***Operations Research*** is a systematic analysis of a problem through scientific methods ,carried out by appropriate specialists, working together as a team ,constituted at the instance of management for the purpose of finding an optimum and the most appropriate solution ,to meet the given objective under a given set constraints."

Meaning of Operations Research:

From the concept and definition given above, Operations Research is:

1. The application of scientific methods, techniques and tools to the problem to find an answer
2. A management tool in the hands of a manager to take a decision
3. A scientific approach to decision making process
4. An ***"applied research"*** aims at finding a solution for an immediate problem facing a society, industry or a business enterprise .This is not "***fundamental research***"
5. A decision-oriented research, using scientific methods, for providing management a quantitative basis for taking decision regarding operations under its control
6. Applied decision theory. It uses scientific, mathematical and logical means to take decisions.

The Operational Research Society of U.K. defines OR as:

> "Operational Research is the application of the methods of science to complex problems arising in the direction and management of large systems of men, machines, materials and money in industry, business, government and defense. The distinctive approach is to develop a scientific model of the system, incorporating measurements of factors, such as chance and risk, with which to compare the outcome of alternative decisions, strategies and controls. The purpose is to help management determine its policies and actions scientifically."

In the USA, where it is called Operations Research, the OR Society of America says more briefly;

"OR is concerned with scientifically deciding how to best design and operate man-machine systems, usually under conditions requiring the allocation of scarce resources"

Nature and significance of operations research

As the term implies, OR involves research on military operations. The operation research approach is particularly useful in balancing conflicting objectives where there are many alternative courses of action available to the decision maker. In a theoretical sense, the optimum decision (global optimum) must be one that is best for the organization as a whole

Operations research attempts to resolve the conflicts of interest among various sections of the organization and seeks the optimal solution which may not be acceptable to one department but is in the interest of the organization as a whole.

OR is concerned with providing the decision maker with decision aids (or rules) derived from:

i. A total system orientation
ii. Scientific methods of investigation, and
iii. Models of reality, generally based on quantitative measurement and techniques

Feature of operations research

Interdisciplinary Approach

Interdisciplinary teamwork is essential because while attempting to solve a complex management problem, one person may not have the complete knowledge of all its aspects (such as economic, social, political, psychological, engineering etc).

Methodological approach

Operations research is the application of scientific methods, techniques and tools to problems involving the operation of systems so as to provide those in control of operations with optimum solutions to the problem.

Wholistic Approach

While arriving at a decision, an operation research team examines the relative importance of all conflicting and multiple objectives, and the validity of claims of various departments of the organization from the perspective of the whole organization.

Objectivistic Approach

An operation research approach seeks to obtain an optimal solution to the problem under analysis. For this a measure of desirability (effectiveness) is defined, based on the objective(s) of the organization. A measure of desirability so defined is then used to compare alternative courses of action with respect to their outcomes.

Models and modeling in operations research

The approximation or abstraction, maintaining only the essential elements of the system, which may be constructed with various forms by establishing relationships among specified variables and parameters of the system, is called a model.

Models attempt to describe the essence of a solution or activity by abstracting from reality so the decision maker can study the relationship among relevant variables in isolation. Hence, models do not, and cannot represent every aspect of reality because of the innumerable and changing characteristics of the real life problems to be represented. Instead, they are limited approximation of reality.

A model is constructed to analyze and understand the given system for the purpose of improving its performance. The reliability of the solution obtained from a model depends on the validity of the model in representing the system under study.

Management Science/Operations Research/ Quantitative Techniques

The Industrial Revolution of the 19th century probably did more to shape life in the modern industrialized world than any event in history. Large factories with mass production created a need for managing them effectively and efficiently. The field of Decision Science (DS) also known as Management Science (MS), Operations Research (OR) in a more general sense, started with the publication of The Principles of Scientific Management in 1911 by Frederick W. Taylor. His approach relied on the measurement of industrial productivity and on time /movement studies in the factories. The goal of his scientific management was to determine the best method for performing tasks in the least amount of time, while unfortunately using the stopwatch in an inhumane manner.

A basic education in OR/MS/DS/SS for managers is essential. They are responsible for leading the business system and the lives in that system. The business system is dynamic in nature and will respond as such to disturbances internally and externally.

The OR/MS/DS/SS approach to decision making includes the diagnosis of current decision making and the specification of changes in the decision process. Diagnosis is the identification of problems (or opportunities for improvement) in current decision behavior; it involves determining how decisions are currently made, specifying how decisions should be made, and understanding why decisions are not made as they should be. Specification of changes in decision process involves choosing what specific improvements in decision behavior are to be achieved and thus defining the objectives.

Nowadays, the OR/MS/DS/SS approach has been providing assistance to managers in developing the expertise and tools necessary to understand the decision problems, put them in analytical terms and then solve them. The OR/MS/DS/SS analysts are, e.g., "chiefs of staff for the president", "advisors", "R&D modelers" "systems analysts", etc. Applied Management Science is the science of solving business problems. The major reason that MS/OR has evolved as quickly as it has is due to the evolution in computing power.

Foundations of Good Decision-Making Process: When one talks of "foundations", usually it includes historical, psychological, and logical aspects of the subject. The foundation of OR/MS/DS/SS is

built on the philosophy of knowledge, science, logic, and above all creativity.

Almost all decision problems have environments with similar components as follows:

1. *The decision-maker. The term decision-maker refers to an individual, not a group.*
2. *the analyst who models the problem in order to help the decision maker,*
3. *Controllable factors (including your personal abilities and physical resources),*
4. *Uncontrollable factors,*
5. *the possible outcomes of the decision,*
6. *The environment/structural constraints*
7. *Dynamic interactions among these components.*

Deterministic versus Probabilistic Models: All the decision models can be classified as either deterministic or probabilistic models. In deterministic models your good decisions bring about good outcomes. You get that which you expect, therefore the outcome is deterministic (i.e., risk-free). However, in probabilistic decision models, the outcome is uncertain; therefore making good decisions may not produce good outcomes. Unlike deterministic models where good decisions are judged by the outcome alone, in probabilistic models, the decision maker is concerned with both the outcome value and the amount of risk each decision carries. When the outcome of your decision is rather certain and all the important consequences occur within a single period, then your decision problem is classified as a deterministic decision. However, in many instances, these types of models are encumbered with the two most difficult factors - uncertainty and delayed effects. Both difficulties can be overcome by probabilistic modeling, which includes the time discounting factor.

After recognizing classification of decision-making components, the OR/MS/DS/SS analyst performs the following sequence with some possible feedback loops between its steps:

1. ***Understanding the Problem***: It is critical for a good decision maker to clearly understand the problem, the objective, and the constraints involved.
2. ***Constructing an Analytical Model***: This step involves the "translation" of the problem into precise mathematical language in order to make calculations and comparison of the outcomes under different possible scenarios.
3. ***Finding a Good Solution***: It is important here to choose the proper solving technique, depending on the specific characteristics of the model. After the model is solved, validation of the obtained results must be done in order to avoid an unrealistic solution.
4. ***Communicating the Results with the Decision-Maker***: The results obtained by the OR/MS/DS/SS analyst have to be properly communicated to the decision-maker. This is the "sale" part. If the decision-maker does not buy the OR/MS/DS/SS analyst recommendations, he/she will not implement any of them.

Successful OR/MS/DS/SS modeling approach to decision-making demands a proper attitude as well as an understanding of more technical matters.

Decision Science (DS) known also as Operations Research (OR), Management Science (MS), and Success Science (SS) is the science of making decisions. To manage means to utilize what is controllable, and to be able to predict what is uncontrollable in order to achieve a specific objective. Science is a continuing search; it is a continuing generation of theories, models, concepts, and categories. Management Science is the science for managing and almost always involves decision-making.

In search of the genealogy of OR/MS, we might ask ourselves a more general question "What is OR/MS/DS/SS?"

What Is OR/MS/DS/SS

Management Science (MS) often takes an analytical view of a decision before making a decision. That is, reflection before action, as a Chinese proverb says, "To chop a tree quickly, spend twice the

time sharpening the ax." Carpenters say, "Measure twice, cut once." It's no delay to stop to edge the tool.

This analytical approach is known by several different names: Operations Research (OR), Operational Research (a UK-ism), Decision Sciences (DS), Systems Science, Mathematical Modeling, Industrial Engineering, Critical Systems strategic thinking, Success Science (SS), and Systems Analysis and Design. Analytical methods are applied to planning and management problems in areas such as production and operations, inventory management, and scheduling. Techniques, often using powerful computer programs, are available to solve problems ranging from real-time control of specific business, industrial, agricultural, and administrative operations to long-term planning models for corporations and public sector agencies.

It is ironic that the idea of utilizing knowledge from a variety of disciplines was a central tenet of the early days in OR/MS. From the beginning, practical problems did not fit into neat disciplinary boundaries. OR/MS/DS/SS became established in organizations and interdisciplinary teams and positions included mathematicians, statistician, psychologists, economists, sociologists, etc. However, over the years the interdisciplinary teams were broken up and new recruits into OR/MS/DS/SS tended to come from applied mathematical and statistical backgrounds.

Academically, OR/MS/DS/SS became increasingly focused on mathematical models and strategic solution algorithms. OR/MS/DS/SS was locked into a hard, technical shell. In recent years, however, this situation is changing with the arrival of "soft" methodologies and critical systems strategic thinking.

Systems modeling process depict a complex problem, with its many, interconnected variables, in a way that amplifies and clarifies our understanding of the decision problem. A good model does not solve the problem in itself, but allows us to experiment with different systems variables to come up with new ideas about how to tackle the decision problem.

The typical OR/MS/DS/SS approach is to build a model for the problem being studied. Such a model is often (but not always) mathematical. Practical problems are often unstructured and the

definition and clarification of problems, as well as the building of models, is an important part of the OR/MS/DS/SS methodology. Most people discover that the understanding created by building a model is a very valuable part of an OR/MS/DS/SS project. Once a model is built, algorithms often have to be used to solve it. An algorithm is a series of steps that will accomplish a certain task. The study, understanding, and invention of such algorithms is also an important part of OR/MS/DS/SS modeling for decision-making. The decision maker might incorporate some other perspectives of the problem such as cultural, psychological, etc., into the management scientist's recommendations. Finally, communicative and political skills are needed in implementing the results of an OR/MS/DS/SS model in a real-life situation. OR/MS/DS/SS models are aimed at assisting the decision-maker in his/her decision-making process.

You may ask, "Why must we learn the decision-making process?" Here are a few motivating reasons:

- *Organizations are becoming more complex.*
- *Environments are changing so rapidly that past practices are no longer adequate.*
- *The costs of making bad decisions have increased.*

The field of OR/MS/DS/SS is always changing. Its changes are driven by the technology it uses and that it extends, and the applications that it affects.

Progressive Approach to Modeling: Modeling for decision making involves two distinct parties, one is the decision-maker and the other is the model-builder known as the analyst. The analyst is to assist the decision-maker in his/her decision-making process. Therefore, the analyst must be equipped with more than a set of analytical methods.

Specialists in model building are often tempted to study a problem, and then go off in isolation to develop an elaborate mathematical model for use by the manager (i.e., the decision-maker). Unfortunately the manager may not understand this model and may either use it blindly or reject it entirely. The specialist may feel that the manager is too ignorant and unsophisticated to appreciate the

model, while the manager may feel that the specialist lives in a dream world of unrealistic assumptions and irrelevant mathematical language.

Such miscommunication can be avoided if the manager works with the specialist to develop first a simple model that provides a crude but understandable analysis. After the manager has built up confidence in this model, additional detail and sophistication can be added, perhaps progressively only a bit at a time. This process requires an investment of time on the part of the manager and sincere interest on the part of the specialist in solving the manager's real problem, rather than in creating and trying to explain sophisticated models. This progressive model building is often referred to as the bootstrapping approach and is the most important factor in determining successful implementation of a decision model. Moreover the bootstrapping approach simplifies otherwise the difficult task of model validating and verification processes.

The OR/MS/DS/SS modeling process is more than a set of analytical methods. OR/MS/DS/SS models are aimed at assisting the decision-maker in his/her decision-making process. A fundamental part of OR/MS/DS/SS modeling is the "systems approach" to problem solving. This approach indicates that the context of organizational problems is as important as the stated problem. Defining a problem, collecting data, consulting with people involved in the solution, and implementing change are all aspects of the OR/MS/DS/SS education and training. As it is easier to make plans than to carry them out, models that are not to be implemented are ones that were not drawn up correctly and taken seriously from the start.

The OR/MS/DS/SS modeling process helps to improve operations in business and government through the use of scientific methods and the development of specialized techniques. Operations Research is not "research"; it is the process cycle of re-searching for an optimal (or desirable) strategic solution to the existing decision problem/situation.

OR/MS/DS/SS modeling process provides systematic and general approaches to problem solving for decision-making, regardless of

the nature of the system, product, or service. The approaches and tools used in OR/MS/DS/SS models are based on one or more of the following analytical methods, simulation, and qualitative or logical reasoning. Many of these tools and approaches depend on computer-based methodologies for implementation.

Cycle of Decision-Making

In summary, the OR/MS/DS/SS modeling process is the application of scientific methods to complex organizational decision problems/opportunities. The OR/MS/DS/SS models are aimed at assisting the decision-maker in his/her decision-making process. This modeling process is now widely used in the manufacturing industry, least cost distribution of goods, and finance functions as well as in service industries, and the health and education sectors. Improvement of an existing system and good designs for new systems are the aims of OR/MS.

The OR/MS/DS/SS modeling process is one of the greatest innovative decision-making tools of the twentieth century.

Historical Needs for OR/MS

Until the middle of the 19th century, most industrial enterprises only employed a few workers. However, as companies expanded, it became less and less feasible for one person to manage all of the new managerial functions of the business effectively. New scientific methodologies were developed to provide assistance to each new type of managerial function as it appeared. As more specialized forms of management emerged, more specialized sub-functions, such as statistical quality control, equipment maintenance, marketing research, and inventory control emerged. Whenever a managerial function is broken down into a set of different sub-functions, a new task, called the executive function of management, is created to integrate the diverse sub-functions so that they efficiently serve the interests of the business as a whole. The executive function evolved gradually with organizations themselves. However, increasing demands were made on the manager who, in turn, sought aid outside the organization. This gave rise to management consultants. What we call OR/MS/DS/SS today is, in fact, the use of scientific tools to aid the executive.

OR originated in Great Britain during World War II to bring mathematical or quantitative approaches to bear on military operations. Since then OR/MS/DS/SS has evolved to be applicable to the management of all aspects of a system, product, or service, and hence is often referred to as Systems Science or Management Science. It has now become recognized as an important input to decision-making in a wide variety of applications in business, industry, and government.

The term OR arose in the 1940's when research was carried out on the design and analysis of mathematical models for military operations. Since that time the scope of OR has expanded to include economics (known as econometrics), psychology (psychometrics), sociology (sociametrics), marketing (marketing research and marketing science), astrology (astronomy), and corporate planning problems. The growing complexity of management has necessitated the development of sophisticated mathematical techniques for planning and decision-making, and the OR/MS/DS/SS features prominently in this structured decision-making process cycle by providing a quantitative evaluation of alternative policies, plans, and decisions. The mathematical disciplines most widely used in OR/MS/DS/SS modeling process include mathematical programming, probability and statistics, and computer science. Some areas of OR, such as inventory control, production control, and scheduling theory, have grown into sub-disciplines of their own right and have become largely indispensable in the modern world.

Military organizations had gone through the same type of evolution as other businesses and industries. This organizational evolution took place in the twenty year gap between the end of World War I and the beginning of World War II when the military leadership had to turn to teams of scientists for aid. These teams of scientists were usually assigned to the executive in charge of operations; hence their work came to be known as Operational Research in the United Kingdom and by a variety of names in the United States: Operation Research, Decision Science, Operational Analysis, System analysis, Success Science, and Management Science. The name Operations Research is the most widely used.

The potential of computer and information systems as new tools for management forced the non-technically trained executives to begin to look for help in the utilization of the computer. The emerging search for assistance was accelerated by the outbreak of the Korean War. This vigorous growth of OR in the military continued to provide rapid applicability to other industries and sectors.

The Nature and Meaning of OR/MS/DS/SS

Many definitions of OR/MS/DS/SS have been offered, as well as many arguments as to why it cannot be defined. The following definitions provide a useful basis for an initial understanding of the nature of OR/MS:

A scientific method of providing executive management with a quantitative base for decisions regarding operations under their control (Mores-Kimball 1943).

The application of the scientific method by inter-disciplinary teams to problems involving the control of organized (man-machine) systems so as to provide solutions which best serve the purpose of the organization as a whole (Ackoff- Sasieni 1968).

Scientific approach to problem solving for executive management (Wagner 1969).

Optimal decision-making in, and modeling of, deterministic and probabilistic systems that originate from real life. These applications, which occur in government, business, engineering, economics, and the natural and social sciences, are largely characterized by the need to allocate limited resources. In these situations, considerable insight can be obtained from scientific analysis, such as that provided by OR/MS/DS/SS (Hiller-Lieberman 1974).

A branch of applied mathematics wherein the application is to the decision-making process (Gross 1979).

Comparing definitions given by More-Kimball and Gross, the divergence is notable after almost 40 years: in one case, OR/MS/DS/SS is defined as scientific method, while in the other it is seen as a branch of mathematics.

In examining these definitions, it should be noted that neither the old and well-established scientific discipline nor science itself has ever been defined in a way that is acceptable to most practitioners.

The Methodology of OR/MS

OR/MS/DS/SS is the scientific method of decision-making. In most discussions of the general scientific method you would find certain stages and essential processes:

Although these phases of an OR/MS/DS/SS project are normally initiated in the order listed, they usually do not terminate in this order. In fact, each stage usually continues until the project is completed and continuously interacts with the others.

> ***Reference:*** *http://home.ubalt.edu/ntsbarsh/Business-stat/home.html*

1.1.

1.2. DECISION MAKING

Making appropriate decision is the most **VITAL** aspect in management .Every one of us takes a number decisions every day. Some are important; some are trivial. Some decisions initiate a set of activities; some put an end to a certain activities. In business environment right decisions at the right times ensure success. This shows the importance of decision making.

-Problem is any variation between what was planned and what is actually have/produced.

-Problem solving can be defined as the process of identifying a difference between some actual and some desired states of affairs and then taking action to resolve the difference.

-Decision making requires for al human being because each of us make decision every day in our life .Thus, decision making is universal. Decision making is a rational selection among alternatives.

Definition

Decision making is the process of selecting or choosing based on some criteria, the best alternative among alternatives.

The decision making process:

Steps in the process of rational decision making

1. *Identify and define the problem*
   Problem is a necessary condition for a decision. ***i.e***: There would be no need for decisions if problems did not exist.
2. *Determine the set of alternative solutions.*
3. *Determine the criteria to evaluate alternatives.*
   =>Identifying those characteristics that are important in making the decision.
4. *Analyze the alternatives.*
   ==>The advantages and disadvantages of each alternative.
5. *Select the best alternative*
   ==> Select the best alternative that suits to solve our decision problem. In selecting the best alternative, factors such as risk, timing and liiting factors should be considered adequately
6. *Implement the solution*
   ==> Putting the decision into action
7. *Establishing a control and evaluation system*
   ==>On going actions need to be monitored
   ==>Following the decision
   ==>Evaluate the results and determine if a satisfactory solution has been obtained.

The Decision-Making Environment

Decisions are made under three basic conditions:

- ***Decision under certainty***
- ***Decision under risk***
- ***Decision under uncertainty***

i. Decision making under conditions of certainty

The decision maker has perfect knowledge about the outcome.

In this situation, we are reasonably sure what will happen when we make a decision. The information is available & is considered to be reliable & we know the cause & effect relationships.

Example: If you decide to invest your money in saving account in the Commercial Bank of Ethiopia, You are certain that you will earn three percent interest.

ii. Decision making under condition of risk

Usually, decision makers cannot have a precise knowledge about the outcome of a decision.

Decision makers may only be able to attach a probability to the expected outcomes of each alternative.

Under this situation, one may have factual information, but it may be incomplete.

Example: If we gamble by tossing a fair coin, the probability that a tail will turn up is 50%.

iii. Decision making under conditions of uncertainty

It is a case where neither there is complete data nor probabilities can be assigned to the surrounding condition. It is the most difficult for a manager.

Some conditions that are uncontrollable by management include competition, government regulations, technological advances, the overall economy, & the social & cultural tendencies of society.

Example: A corporation that decides to expand its operation, launching a new product, or developing of a new technology in a strong country may know little about its culture, laws, economic environment, or politics. The political situation may be so volatile that even experts cannot predict a possible change in government.

1.3. QUNATITIATIVE ANALYSIS PROCESS

*Qualitative skill can be developed through experience. It is inherent.

The three basic quantitative analysis processes are:

1. *Model development*
2. *Data preparation*
3. *Model solution*

1.Model development

Model is a representation of real objects/situations

Following are types of models:

a. Physical (icon) model

This is the representation of the situation, problem or object.

It is also called ***Static Model***. It is given in two or three dimensions.

It is a representation of the real object.

Example:

- *The structure of an atom*
- *Model of an airplane*
- *Photograph of a machine*
- *Layout drawing of a factory*
- *Glob*

b . Analogue Models:

These are abstract models mostly showing inter and intra relationships between two or more parameters.

For example:

It may show the relationship between an independent variable (input) with that of a dependent variable (output). For instance; histogram, frequency table, cause-effect diagram, flow charts, Gantt charts, price-demand graph, world map and others.

:Is two dimensional.

c. Mathematical models

This is also an abstract model. Here a set of relations is represented in the form of mathematical equations, using symbols to represent various parameters.

Example:

1. $(x + y)^2=x^2+2xy+y^2$

2. Max.Z=$3000x_1 +2500x_2$

Subject to:

$2x_1+x_2 \leq 40$
$x_1+3x_2 \leq 45$
$x_1 \leq 12$
$x_1, \quad x_2 \geq 0$

x_1 and x_2 are decision variables

Objective Function:

A mathematical statement of the goal of an organization, stated as intent to maximize or to minimize some important quantity such as profits or costs.

Max.Z=$3000x_1 + 2500x_2$ is the objective function

Constraint:

A restriction on the resources available to a firm (stated in the form of an inequality or an equation.)

$2x_1+x_2 \leq 40$
$x_1+3x_2 \leq 45$
$x_1 \leq 12$
$x_1, x_2 \geq 0$

Are constraints

$x_1, x_2 \geq 0$ is non-negativity constraint

2. Data presentation

Data represent the values of inputs to the model.

Max.Z=$3000x_1 + 2500x_2$
Subject to:

$2\ x_1+x_2 \leq 40$
$x_1+3x_2 \leq 45$
$x_1 \leq 12$
$x_1, x_2 \geq 0$

3. Model solution

:Is optimal solution

From the above equation, x_1=12, x_2=11 and Max.Z= $6350

Trial and error method

In this method a certain algorithm is developed. One starting point is an initial solution, which is the first approximation .The method of solution, is repeated with a certain set of rules so that initial solution is gradually modified at each subsequent solution; till optimal solution is reached. There are certain criteria laid down to check whether the solution has become an optimal solution. These trial solutions are called ***Iterations*** and the method is called ***iterative process***. The classical example of trial and error method is Linear Programming

Then the next step after iteration is *model testing and validation*.

1.4. MANAGEMENT SCIENCE IN PRACTICE

There are various techniques used in O.R. Some of these are listed here:

- *Probability theory*
- *Linear Programming*
- *Transportation algorithm*
- *Assignment problems*
- *Queuing Theory*
- *PERT/CPM Method etc*

OR techniques are ***'application specific'***. Maximum benefit can be derived from selecting most appropriate techniques for each specific area or problem. Appropriate selection of **OR** is an equally important task. Each technique has its own advantages and limitations .In all such cases, the ability of the Manager is tested in appropriate selection of **OR** technique.

Models and modeling in operations research