Quantitative Analysis for Managerial Applications

UNIT 1 QUANTITATIVE DECISION MAKING - AN OVERVIEW

Objectives

After studying this unit, you should be able to:

- **understand** the complexity of today's managerial decisions
- **know** the meaning of quantitative techniques
- **know** the need of using quantitative approach to managerial decisions
- **appreciate** the role of statistical methods in data analysis
- **know** the various models frequently used in operations research and the basis of their classification
- **have** a brief idea of various statistical methods
- **know** the areas of applications of' quantitative approach in business and management.

Structure

1.1 INTRODUCTION

You may be aware of the fact that prior to the industrial revolution individual business was small and production was carried out on a very small scale mainly to cater to the local needs. The management of such business enterprises was very different from the present management of large scale business. The information needed by the decision-maker (usually the owner) to make effective decisions was much less extensive than at present. Thus he used to make decisions based upon his past experience and intuition only. Some of the reasons for this were:

i) The marketing of the product was not a problem because customers were, for the large part, personally known to the owner of the business. There was hardly any competition in the business.

ii) Test marketing of the product was not needed because the owner used to know the choice and requirement of the customers just by personal interaction.

iii) The manager (also the owner) also used to work with his workers at the shopfloor. He knew all of them personally as the number was small. This reduced the need for keeping personal data.

iv) The progress of the work was being made daily at the work centre itself. Thus production records were not needed.

v) Any facts the owner needed could be learnt direct from observation and most

of what he required was known to him.

Now, in the face of increasing complexity in business and industry, intuition alone has no place in decision-making because basing a decision on intuition becomes highly questionable when the decision involves the choice among several courses of action each of which can achieve several management objectives simultaneously. Hence there is a need for training people who can manage a system both efficiently and creatively.

Quantitative techniques have made valuable contribution towards arriving at an effective decision in various functional areas of management-marketing, finance, production and personnel. Today, these techniques are also widely used in regional planning, transportation, public health, communication, military, agriculture, etc.

Quantitative techniques are being used extensively as an aid in business decision-making due to following reasons:

i) Complexity of today's managerial activities which involve constant analysis of existing situation, setting objectives, seeking alternatives, implementing, co-ordinating, controlling and evaluating the decision made.

ii) Availability of different types of tools for quantitative analysis of complex managerial problems.

iii) Availability of high speed computers to apply quantitative techniques (or models) to real life problems in all types of organisations such as business, industry, military, health, and so on. Computers have played an important role in arriving at the optimal solution of complex managerial problems both in terms of time and cost.

In spite of these reasons, the quantitative approach, however, does not totally eliminate the scope of qualitative or judgement ability of the decision-maker. Of course, these techniques complement the experience and knowledge of decision-maker in decision-making.

1.2 MEANING OF QUANTITATIVE TECHNIQUES

Quantitative techniques refer to the group of statistical, and operations research (or programming) techniques as shown in the following chart. All these techniques require preliminary knowledge of certain topics in mathematics as discussed in Unit 2.

Quantitative Techniques

Statistical Techniques

Operations research (or Programming) Techniques

The quantitative approach in decision-making requires that, problems be defined, analysed and solved in a conscious, rational, systematic and scientific manner based on data, facts, information, and logic and not on mere whims and guesses. In other words, quantitative techniques (tools or methods) provide the decision-maker a scientific method based on quantitative data in identifying a course of action among the given list of courses of action to achieve the optimal value of the predetermined objective or goal. One common characteristic of all types of quantitative techniques is that numbers, symbols or mathematical formulae (or expressions) are used to represent the models of reality.

1.3 STATISTICS AND OPERATIONS RESEARCH

Statistics

The word statistics can be uses, in a number of ways. Commonly it is described in two senses namely:

1 Plural Sense (Statistical Data)

The plural sense of statistics means some sort of **statistical data.** When it means statistical data, it refers to numerical description of quantitative aspects of things, These descriptions may take the form of counts or measurements. For example, statistics of students of a college include count of the number of students, and separate counts of number of various kinds as such, male and females, married and unmarried, or undergraduates and post-graduates. They may also include such measurements as their heights and weights.

2 Singular Sense (Statistical Methods)

The large volume of numerical information (or data) gives rise to the need for systematic methods which can be used to **collect, organise** or **classify, present, analyse** and **interpret** the information effectively for the purpose of making wise decisions. Statistical methods include all those devices of analysis and synthesis by means of which statistical data are systematically collected and used to explain or describe a given phenomena.

The above mentioned five functions of statistical methods are also called **phases** of a statistical investigation. A major part of Block 2 (units 5 to 8) is devoted to the methods used in analysing the presented data. Methods used in analysing the presented data are numerous and contain simple to sophisticated mathematical techniques. However, in Blocks 2 to 5 of the course: Quantitative Analysis for Managerial Applications, only the most commonly used methods of statistical analysis are included.

As an illustration, let us suppose that we are interested in knowing the income level of the people living in a certain city. For this we may adopt the following procedures:

a) **Data collection:** The following data is required for the given purpose:
   - Population of the city
   - Number of individuals who are getting income
   - Daily- income of each earning individual

b) **Organise (or Condense) the data:** The data so obtained should now be organised in different income groups. This will reduce the bulk of the data.

c) **Presentation:** The organised data may now be presented by means of various types of graphs or other visual aids. Data presented in an orderly manner facilitates statistical analysis.

d) **Analysis:** On the basis of systematic presentation (tabular form or graphical form), determine the average income of an individual and extent of disparities that exist. This information will help to get an understanding of the phenomenon (i.e. income of 'individuals).

e) **Interpretation:** All the above steps may now lead to drawing conclusions which will aid in decision-making-a policy decision for improvement of the existing situation.

Characteristics of data

It is probably more common to refer to data in quantitative form as statistical data. But not all numerical data is statistical. In order that numerical description may be called statistics they must possess the following characteristics:

i) **They must be aggregate of facts,** for example, single unconnected figures cannot be- used to study the characteristics of the phenomenon.

ii) **They should be affected to a marked extent by multiplicity of causes,** for example, in social services the observations recorded are affected by a number of factors (controllable and uncontrollable)

iii) **They must be enumerated or estimated according to reasonable standard of accuracy,** for example, in the measurement of height one may measure correct upto 0.01 of a cm; the quality of the product is estimated by certain tests on small samples drawn from a big lot of products.

iv) **They must have been collected in a systematic manner for** a **pre-determined purpose.** Facts collected in a haphazard manner, and without a complete awareness of the object, will be confusing and cannot be made the basis of valid conclusions. For example collected data on price serve no purpose unless one knows whether he wants to collect data on wholesale or retail prices and what are the relevant commodities in view.

v) **They must be placed in relation to each other.** That is, data collected should be comparable; otherwise these cannot be placed in relation to each other, e.g. statistics on the yield of crop and quality of soil are related but these yields cannot have any relation with the statistics on the health of the people.

vi) **They must be numerically expressed.** That is, any facts to be called statistics must be numerically or quantitatively expressed. Qualitative

characteristics such as beauty, intelligence, etc. cannot be included in statistics unless they are quantified.

Types of Statistical Data

An effective managerial decision concerning a problem on hand depends on the availability and reliability of statistical data. Statistical data can be broadly grouped into two categories:

i) Secondary (or published) data

ii) Primary (or unpublished) data

The **secondary data** are those which have already been collected by another organisation and are available in the published form. You must first check whether any such data is available on the subject matter of interest and make use of it, since it will save considerable time and money. But the data must be scrutinised properly since it was originally collected perhaps for another purpose. The data must also be checked for reliability, relevance and accuracy.

A great deal of data is regularly collected and disseminated by international bodies such as: World Bank, Asian Development Bank, International Labour Organisation, Secretariat of United Nations, etc., Government and its many agencies: Reserve Bank of India, Census Commission, Ministries-Ministry of Economic Affairs, Commerce Ministry; Private Research Organisations, Trade Associations, etc.

When secondary data is not available or it is not reliable, you would need to collect original data to suit your objectives. Original data collected specifically for a current research are known as **primary data.** Primary data can be collected from customers, retailers, distributors, manufacturers or other information sources. Primary data may be collected through any of the three methods: observation, survey, and experimentation. You have read in detail about these methods in Unit 7 of Block 2, Marketing Planning and Organisation of the course Marketing For Managers.

Data are also classified as **micro** and **macro.** Micro data relate to a particular unit or region whereas macro data relate to the entire industry, region or economy.

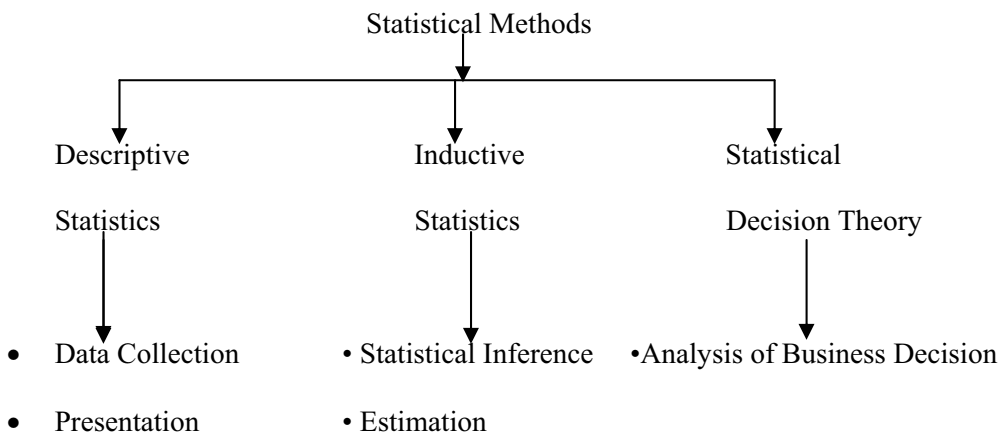
Operations Research

You have read various definitions of operations research in Section 9.4 of **Unit-9 (Block 3) Operations Research and Management Decision-Making of the Course Information Management and Computers.**

You would recall that in Operations Research a mathematical model to represent the situation under study is constructed. This helps in two ways. Either to predict the performance of the system under certain controls. Or to determine the action or control needed to optimise performance.

1.4 CLASSIFICATION OF STATISTICAL METHODS

By now you may have realised that effective decisions. have to be based upon realistic data. The field of statistics provides the methods for collecting, presenting and meaningfully interpreting the given data. Statistical Methods broadly fall into three categories as shown in the following chart.



Descriptive Statistics

There are statistical methods which are used for re-arranging, grouping and summarising sets of data to obtain better information of facts and thereby better description of the situation that can be made. For example, changes in the price-index. Yield by wheat etc. are frequently illustrated using different types of charts and graphs. These devices summarise large quantitatives of numerical data for easy understanding. Various types of averages, can also reduce a large mass of data to a single descriptive number. The descriptive statistics include the methods of collection and presentation of data, measure of Central tendency and dispersion, trends, 'index numbers, etc.

Inductive Statistics

It is concerned with the development of some criteria which can be used to derive information about the nature of the members of entire groups (also called population or universe) from the nature of the small portion (also called sample) of the given group. The specific values of the population members are called `parameters' and that of sample are called `statistics'. Thus, inductive statistics is concerned with estimating population parameters from the sample statistics and deriving a statistical inference.

Samples are drawn instead of a complete enumeration for the following reasons:

i) The number of units in the population may not be known.

ii) The population units may be too many in number and/or widely dispersed. Thus complete enumeration is extremely time consuming and at the end of a full enumeration so much time is lost that the data becomes obsolete by that time.

iii) It may be too expensive to include each population item.

Inductive statistics, includes the methods like: probability and probability distributions; sampling and sampling distributions; various methods of testing hypothesis; correlation, regression, factor analysis; time series analysis.

Statistical Decision Theory .

Statistical decision theory deals with analysing complex business problems with alternative courses of action (or strategies) and possible consequences. Basically, it is to provide more concrete information concerning these consequences, so that best course of action can be identified from alternative courses of action.

Statistical decision theory relies heavily not only upon the nature of the problem on hand, but also upon the decision environment. Basically there are four different states of decision environment as given below:

State of decision	Consequences
Certainty	Deterministic
Risk	Probabilistic
Uncertainty	Unknown
Conflict	Influenced by an opponent

Since statistical decision theory also uses probabilities (subjective or prior) in analysis, therefore it is also called a subjectivist approach. It is also known as Bayesian approach because Baye's theorem is used to revise prior probabilities in the light of additional information.

1.5 MODELS IN OPERATIONS RESEARCH

You have read in detail about various models and techniques in Operations Research in Unit 9 of Block 3-Computers and Decisional Techniques of the course "Information Management and Computers". In this Section we are presenting several classifications of OR models so that you should know more about the role of models in decision-making:

1. Purpose

A Model is the representation of a system which, in turn, represents a specific part of reality (an object of interest or subject of inquiry in real life). The means of representing a system may be physical, graphic, schematic, analogy, mathematical, symbolic or a combination of these. Through all these means, an attempt is made to abstract the essence of reality, which in turn, is quite helpful to **describe, explain** and predict the behaviour of the system Thus, depending upon the purpose,

the stage at which the model is developed, models can be classified into four categories.

i) **Descriptive model:** Such Models are used to describe the behaviour of a system based on certain information. For example, a model can be built to describe the behaviour of demand for an inventory item for a stated period, by keeping the record of various demand levels and their respective frequencies. A descriptive model is used to display the problem situation more vividly including the alternative choices to enable the decision-maker to evaluate results of each alternative choice. However, such model does not select the best alternative.

ii) **Explanatory model:** Such models are used to explain the behaviour of a system by establishing relationships between its various components. For example, a model can be built to explain variations in productivity by establishing relationships among factors such as wages, promotion policy, education levels, etc.

iii) **Predictive model:** Such models are used to predict the status of a system in the near future based on data. For example, a model can be built to predict stock prices (within an industry group), for given any level of earnings per share.

iv) **Prescriptive (or normative) model:** A prescriptive model is one which provides the norms for the comparison of alternative solutions which result in the selection of the best alternative (the most preferred course of action). Examples of such models are allocation models.

2. Degree of Abstraction

The following chart shows the classification of models according to the degree of abstraction:

Model	Degree of Abstraction
• Physical	Least Abstract
• Graphic	↓
• Schematic	↓
• Analog	↓
• Mathematical	Most Abstract

Any three-dimensional model that looks like the real thing but is either reduced in size or scaled up, is a physical (conic) model. These models include city planning maps, plant layout charts, plastic model of airplane, body parts, etc. These models are easy to observe, build and describe, but cannot be manipulated and used for prediction.

An organisation chart showing responsibility relationships is an example of graphic model. A flow chart (or diagram) depicting the sequence of activities during the complete processing of a product is an example of schematic model. Another example of schematic model is the Computer programme where main features of the programme are represented by a schematic description of steps.

Analog models are closely associated with iconic models. However, they are not replicas of problem situations. Rather they are small physical systems that have similar characteristics and work like an object or system it represents. For example, children's toys, model rail-roads, etc. These models might not allow direct handling or manipulation.

Mathematical (or symbolic) models represent the systems (or reality) by using mathematical symbols and relationships. These are very precise, most abstract and can be manipulated by using laws of mathematics. The input-output model of national economy involving several objectives, constraints, inputs and inter-linkages between them is an example of representing a complex system with the help of a set of equations.

3. Degree of Certainty

Models can also be classified according to the degree of assumed certainty. Under this classification models are divided into deterministic versus probabilistic models.

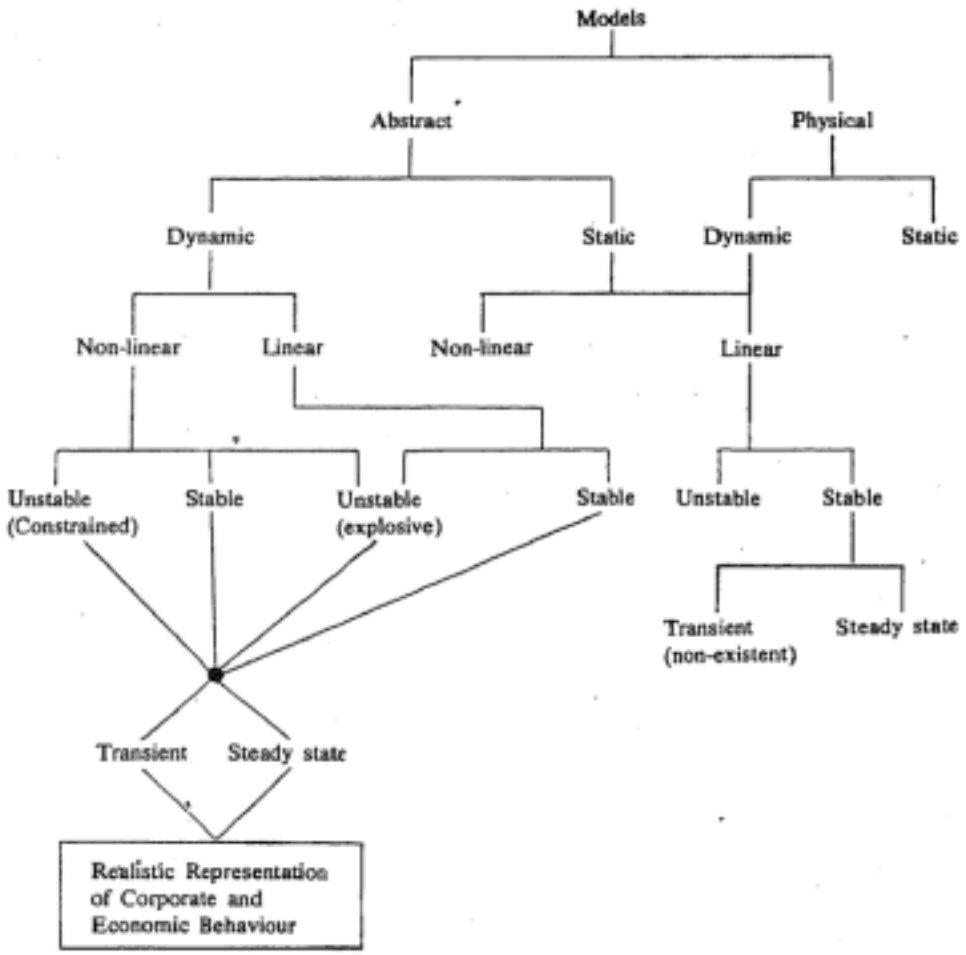
Models in which selection of each course of action (or strategy) results in unique and known pay-off or consequence are called deterministic models. Examples of such models are linear programming, transportation and assignment models.

Situations in which each course of action (or strategy) can result in more than one pay-offs or consequences are called probabilistic models. Since in such models the concept of probability is used, therefore the pay-off or consequences due to a managerial action cannot be predicted with certainty. Examples of such models are, simulation models, decision theory models etc.

4. Specified Behaviour Characteristics

The following chart describes the classification of models based on specified behaviour characteristics. Such type of classification helps in understanding the nature and role of models in representing management and economic status of organisations.

Classification According to Behavior Characteristics



Source: Loomba, M.P. 1978. Management-A Quantitative Perspective; Macmillan Publishing Co.: New York)

The models that are concerned with a particular set of fixed conditions and do not change in a short-term period (or planning period) are known as static models. This implies that such models are independent of time and only one decision is required for a given time period. For example, the resources required for a product and the technology or manufacturing process ¢o not change in short-term period. Linear programming is the particular example of static models. On the other hand, there are certain types of problems where time factor plays an important role and admit the impact of changes over a period of time. In all such situations decision-maker has to make a sequence of optimal decisions at every decision point (i.e. variable time) regardless of what the prior decision has been. The problem of product development in which the decision-maker has to make decisions at every decision point such as product design, test-market, full-scale production, etc. is an example of dynamic model. Dynamic programming is the particular example of dynamic model.

Linear Models are those in which each component exhibits a linear behaviour. The word `linear' is used to describe the relationship among two or more variables which are directly proportional. For example, if our resources increase b some percentage, then it would increase the output by the same percentage. If one or more components of a model exhibit a non-linear behaviour, then such models are called **non-linear models.** A mathematical model of the form Z=5 + 3 is called a linear model whereas a model of the form $Z=5x^2+3xy+y^2$ is called a non-linear model.

5. Procedure (or Method) of Solution

The type of procedure used to derive solutions to mathematical models divides them into two categories: (i) analytical models, and (ii) simulation models.

An analytical model consists of a mathematical structure and is solved by known mathematical or analytical techniques to yield a general solution. Examples of analytical model are: network models (PERT/CPM), linear programming models, game theory models, inventory control models.

A simulation model is the experimentation (Computer assisted or manual) on a mathematical structure of real-life system. It is done by inserting into the given structure specific values of decision variables under certain assumptions in order to describe and evaluate systems behaviour over a period of time. For example, we can test the effect of different number of service counters assuming different arrival rates of customers on total cost of providing service to customers.

The following table summarises our discussion on classification of models.

Criterion Classification	Categories of OR Models
• Purpose	• Descriptive, Explanatory, Predictive, Prescriptive
• Degree of abstraction	• Physical, Graphic, Schematic, Analog, Mathematical
• Degree of Certainty	• Deterministic, Probabilistic Certainty, Risk, Uncertainty
• Specified behaviour characteristics	• Static, Dynamic, Linear Non-linear
• Procedure of solution	• Analytical, Simulation

You have read about certain standard techniques or prototype models of operations research which can be helpful to a decision-maker in solving a variety of problems.

1.6 VARIOUS STATISTICAL TECHNIQUES

A brief comment on certain standard techniques of statistics which can be helpful to a decision-maker in solving problems is given below. However, each one of these techniques requires detailed studies and in our context we are merely listing these to arouse your interest.

i) **Measures of Central Tendency:** Obviously for proper understanding of quantitative data, they should be classified and converted into a frequency distribution (number of times or frequency with which a particular data occurs in the given mass of data). This type of condensation of data reduces their bulk and gives a clear picture of their structure. If you want to know any specific characteristics of the given data or if frequency distribution of one set of data to be compared with another, then it is necessary that the frequency distribution. itself must be summarised and condensed in such a manner that it must help us to make useful inferences about the data and also provide yardstick for comparing different sets of data. Measures of average or central tendency provide one such yardstick. Different methods of measuring central tendency. provide us with different kinds of averages. The main three types of averages commonly used are:

a) **Mean:** The mean is the common arithmetic average. It is computed b}y dividing the sum of the values of the observations by the number of item:: observed.

b) **Median:** The median is that item which lies exactly half-way between the lowest and highest value when the data is arranged in an ascending or descending order. It is not affected by the value of the observation but by the number of observations. Suppose you have the data on monthly income of households in a particular area. The median value would give you that monthly income which divides the number of households into two equal parts. Fifty per cent of all the households have a monthly income above the median value and fifty per cent of households have a monthly income below the median income.

c) **Mode:** The mode is the central value (or item) that occurs most frequently. When the data organised as a frequency distribution the mode is that category which has the maximum number of observations. For example, a shopkeeper ordering fresh stock of shoes for the season would make use of the mode to determine .the size which is most frequently sold. The advantages of mode are that (a) it is easy to compute, (b) is not affected by extreme values in the frequency distribution, and (c) is representative if the observations are clustered at one particular value or class.

ii) **Measures of Dispersion:** The measures of central tendency measure the most typical value around which most values in the distribution tend to converge. However, there are always extreme values in each distribution. These extreme values indicate the spread or the dispersion of the distribution. The measures of this spread are called `measures of dispersion' or `variation' or `spread'. Measures of dispersion would tell you the number of values which are substantially different from the mean, median or mode. The commonly used measures of dispersion are range, mean deviation and standard deviation.

The data may spread around the central tendency in a symmetrical or an asymmetrical pattern. The measures of the direction and degree of symmetry are called measures of the **skewness.** Another characteristic of the frequency distribution is the shape of the peak, when it is plotted on a graph paper. The measures of the peakedness are called measures of **Kurtosis.**

iii) **Correlation:** Correlation coefficient measures the degree to which the change in one variable (the dependent variable) is associated with change in the other variable (independent one). For example, as a marketing manager, you would like to know if there is any relation between the amount of money you spend on advertising and the sales you achieve. Here, sales is the dependent variable and advertising budget is the independent variable. Correlation coefficient, in this case, would tell you the extent of relationship between these two variables, whether the relationship is directly proportional (i.e. increase or decrease in advertising is associated with increase or decrease in sales) or it is an inverse relationship (i.e. increasing advertising is associated with decrease in sales and vice-versa) or there is no relationship between the two variables. However, it is important to note that correlation coefficient does not indicate a casual relationship, Sales is not a direct result of advertising alone, there are many other factors which affect sales. Correlation only indicates that there is some kind of association-whether it is casual or causal can be determined only after further investigation. You may find a correlation between the height of your salesmen and the sales, but obviously it is of no significance.

iv) **Regression Analysis:** For determining causal relationship between two variables you may use regression analysis. Using this technique you can predict the dependent variables on the basis of the independent variables. In 1970, NCAER (National Council of `Applied and Economic Research) predicted the annual stock of scooters using a regression model in which real personal disposable income and relative weighted price index of scooters were used as independent variable.

The correlation and regression analysis are suitable techniques to find relationship between two variables only. But in reality you would rarely

find a one-to-one causal relationship, rather you would find that the dependent variables are affected by a number of independent variables. For example, sale affected by the advertising budget, the media plan, the content of the advertisements, number of salesmen, price of the product, efficiency of the distribution network and a host of other variables. For determining causal relationship involving two or more variables, multi-variate statistical techniques are applicable. The most important of these are the **multiple regression analysis, discriminant analysis** and **factor analysis.**

v) **Time Series Analysis:** A time series consists of a set of data (arranged in some desired manner) recorded either at successive points in time or over successive periods of time. The changes in such type of data from time to time are considered as the resultant of the combined impact of a force that is constantly at work. This force has four components: (i) Editing time series data, (ii) secular trend, (iii) periodic changes, cyclical changes and seasonal variations, and (iv) irregular or random variations. With time series analysis, you can isolate and measure the separate effects of these forces on the variables. Examples of these changes can be seen, if you start measuring increase in cost of living, increase of population over a period of time, growth of agricultural food production in India over the last fifteen years, seasonal requirement of items, impact of floods, strikes, wars and so on.

vii) **Index Numbers:** Index number is a relative number that is used to represent the net result of change in a group of related variables that has some over a period of time. Index numbers are stated in the form of percentages. For example, if we say that the index of prices is 105, it means that prices have gone up by 5% as compared to a point of reference, called the base year. If the prices of the year 1985 are compared with those of 1975, the year 1985 would be called "given or current year" and the year 1975 would be termed as the "base year". Index numbers are also used in comparing production, sales price, volume employment, etc. changes over period of time, relative to a base.

viii) **Sampling and Statistical Inference:** In many cases due to shortage of time, cost or non-availability of data, only limited part or section of the universe (or population) is examined to (i) get information about the universe as clearly and precisely as possible, and (ii) determine the reliability of the estimates. This small part or section selected from the universe is called the sample, and[1] the process of selections such a section (or past) is called sampling:

Scheme of drawing samples from the population can be classified .into two broad categories:

a) **Random sampling schemes:** In these schemes drawing of elements from the population is random and selection of an element is made in such a way that every element has equal chance (probability) of being selected.

b) **Non-random sampling schemes:** In these schemes, drawing of elements from the population is based on the choice or purpose of selector.

The sampling analysis through the use of various `tests' namely Z-normal distribution, student's `t' distribution; F-distribution and x^2-distribution make possible to derive inferences about population parameters with specified level of significance and given degree of freedom. You will read about a number of tests in this block to derive inference about population parameters.

1.7 ADVANTAGES OF QUANTITATIVE APPROACH TO MANAGEMENT

Executives at all levels in business and industry come across the problem of making decision at every stage in their day-to-day activities. Quantitative techniques provide the executive with scientific basis for **decision-making** and **enhance his ability** to matte long-range plans and to solve every day problems of running a business and industry with greater efficiency and confidence.

You have read the advantages of the study of operations research in decision-making in Unit 9 of Block 3: Computer and Decisional Techniques of the course MS-7. Let us now also look at some of the advantages of the study of statistics:

1 **Definiteness:** The study of statistics helps us in presenting general statements in a precise and a definite form. Statements of facts conveyed numerically are more precise and convincing than those stated qualitatively. For example, the statement that "literacy rate as per 1981 census was 36% compared to 29% for 1971 census" is more convincing than stating simply that "literacy in our country has increased".

2 **Condensation:** The new data is often unwieldy and complex. The purpose of statistical methods is to simplify large mass of data and to present a meaningful information from them. For example, it is difficult to form a precise idea about the income position of the people of India from the data of individual income in the country. The data will be easy to understand and more precisely if it can be expressed in the form of per capita income.

3 **Comparison:** According to Bodding, the object of statistics is to enable comparisons between past and present results with a view to ascertaining the reasons for change which have taken place and the effect of such changes in the future. Thus, if one wants to appreciate the significance of figures, then he must compare them with other of the same kind. For example, the statement "per capita income has increased considerably" shall not be meaningful unless some comparison of figures of past is made. This will help in drawing conclusions as to whether the standard of living of people of India is improving.

4 **Formulation of policies:** Statistics provides the basic material for framing policies not only in business but in other fields also. For example, data on birth and mortality rate not only help is assessing future growth in population but also provide necessary data for framing a scheme of family planning.

5 **Formulating and testing hypothesis:** Statistical methods are useful in formulating and testing hypothesis or assumption or statement and to develop new theories. For example, the hypothesis: "whether a student has benefited from a particular media of instruction", can be tested by using appropriate statistical method.

6 **Prediction:** For framing suitable policies or plans, and then for implementation it is necessary to have the knowledge of future trends. Statistical methods are highly useful for forecasting future events. For example, for a businessman to decide how many units of an item should be produced in the current year, it is necessary for him to analyse the sales data of the past years.

1.8 QUANTITATIVE TECHNIQUES IN BUSINESS AND MANAGEMENT

You have read about applications• of operations research in various functional areas of management in unit 9 of block 3, of-the course Information Management and Computers. Some of the areas where statistics can be used are as follows:

Management

i) Marketing:

- Analysis of marketing research information
- Statistical records for building and maintaining an extensive market
- Sales forecasting

ii) Production:

- Production Planning, control and analysis
- Evaluation of machine performance
- Quality control requirements
- Inventory control measures

iii) Finance, Accounting and Investment:

- Financial forecast, budget preparation
- Financial investment decisions
- Selection of securities
- Auditing function
- Credit policies, credit risk and delinquent accounts

iv) Personnel:

- Labour turn over rate
- Employment trends
- Performance appraisal
- Wage rates and incentive plans

Economics

- Measurement of gross national product and input output analysis
- Determination of business cycle, long-term growth and seasonal fluctuations
- Comparison of market prices, cost and profits of individual firms
- Analysis of population, land economics and economic geography
- Operational studies of public utilities
- Formulation of appropriate economic policies and evaluation of their effect

Research and Development

- Development of new product lines
- Optimal use of resources
- Evaluation of existing products

Natural Science

- Diagnosing the disease based on data like temperature, pulse rate, blood pressure etc.
- Judging the efficacy of a particular drug for curing a certain disease
- Study of plant life

1.9 USE OF COMPUTERS

The use of computers has become closely associated with quantitative techniques. With the evolution of more powerful computing techniques, users of these techniques are encouraged to explore new and more sophisticated methods of data analysis. Computers have the advantage of being a relatively inexpensive means of processing large amount of data quickly and accurately.

Computers have provided a means for solving those problems which have long been quantifiable but computationally too complex or time-consuming for manual calculation. Problems which would take months to solve manually can be solved in a few minutes using computers.

1.10 SUMMARY

There is an ever-increasing demand for managers with numerate ability as well as literary skills, so that they can present numerate data and information which requires analysis and interpretation but, more importantly, they can quickly scan and understand analysis provided both from within the firm and by outside organisations, In the competitive and dynamic business world, those enterprises which are most likely to succeed, and indeed survive are those which are capable of maximising the use of the tools of management including quantitative techniques.

This unit has attempted to describe the meaning and use of various quantitative techniques in the field of business and management. The importance and complexity of the decision-making process has resulted in the wide application of quantitative techniques in the diversified field of business and management. With the evolution of more powerful computing techniques, users of these techniques are encouraged to explore new and more sophisticated methods of data analysis. Quantitative approach in decision-making however does not totally eliminate the scope of qualitative or judgement ability of the decision-maker.

1.11 KEY WORDS

Descriptive models: Models which are used to describe the behaviour of a system based on data.

Descriptive statistics: It is concerned with the analysis and synthesis of data so that better description of the' situation can be made.

Explanatory models: Models which are used to explain behaviour of a system by establishing relationships between its various components.

Inductive statistics: It is concerned with the developments of scientific criteria which can be used to derive information about the group of data by examining only a small portion (sample) of that group.

Operations research: It is a scientific method of providing executive departments with a quantitative basis for decision regarding the operations under control.

Predictive models: Models which are used to predict the status of a system in the near future based on data.

Quantitative techniques: It is the name given to the group of statistical and operations research (or programming) techniques.

Statistical data: It refers to numerical description of quantitative aspects of things. These descriptions may take the form of counts or measurement.

Statistical decision theory: It is concerned with the establishment of rules and procedures for choosing the course of action from alternative courses of actions under situation of uncertainty.

Statistical methods: These methods include all those devices of analysis and synthesis by means of which statistical data are systematically collected and used to explain or describe a given phenomenon.

1.12 SELF-ASSESSMENT EXERCISES

1 Think of any major decision you made recently. Recall the steps taken by you to arrive at the final decision. Prepare a list of those steps.

2 Comment on the following statements:

   a) "Statistics are numerical statement of facts but all facts numerically stated are not statistics".

   b) "Statistics is the science of averages".

3 What is the type of the following models?

   a) Frequency curves in statistics,

   b) Motion films,

   c) Flow chart in production control, and

   d) Family of equations describing the structure of an atom.

4 List at least two applications of statistics in each, functional area of management.

5 What factors in modern society contribute to the increasing importance of quantitative approach to management?

6 Describe the major phases of statistics. Formulate a business problem and analyse it by applying these phases.

7 Explain the distinction between:

   a) Static and dynamic models

   b) Analytical and simulation models

   c) Descriptive and prescriptive models.

8 Describe the main features of the quantitative approach to management.

1.13 FURTHER READINGS

Gupta, S.P. and M.P. Gupta, 1987. *Business Statistics,* Sultan Chand & Sons: New Delhi.

Loomba, M.P., 1978. *Management-A Quantitative Perspective,* MacMillan Publishing Company: New York.

Shenoy; G.V., U.K. Srivastava and S.C. Sharma, 1985. *Quantitative Techniques for Managerial Decision Making, Wiley* Eastern: New Delhi.

Venkata Rao, K., 1986. *Management Science,* McGraw-Hill Book Company: Singapore.

UNIT 2 FUNCTIONS AND PROGRESSIONS

Objectives

After studying this unit, you should be able to understand and appreciate:

- the need to **identify** or **define** the relationships that exists among business variables
- how to **define** functional relationships
- the **various types** of functional relationships
- the **use** of graph to depict functional relationships
- the **managerial** applicability and use of functional relationships in diverse fields
- the **progressions** and their applications.

Structure

2.1 INTRODUCTION

For decision problems which use mathematical tools, the first requirement is to identify or formally define all significant interactions or relationships among primary factors (also called variables) relevant to the problem. These relationships usually are stated in the form of an equation (or set of equations) or inequations. Such type of simplified mathematical relationships help the decision-maker in understanding (any) complex management problems. For example, the decision-maker knows that demand of an item is not only related to price of that item but also to the price of the substitutes. Thus if he can define specific mathematical relationship (also called model) that exists, then the demand of the item in the near future can be forecasted. The main objective of this unit is to study mathematical relationships (or functions) in the context of managerial problems.

2.2 DEFINITIONS

Variable

A variable is something whose magnitude can vary or which can assume various values. The variables used in applied mathematics include: sale, price, profit, cost, etc. Since magnitude of variables can vary, therefore these are represented by symbols (such as x, y, z etc.) instead of a specific number. In applied mathematics a variable is represented by the first letter of its name, for example p for price or profit; q for quantity, c for cost; s for saving or sales; d for demand and so forth. When we write x=5, the variable takes specific value.

Variables can be classified in a number of ways. For example, a variable can be **discrete** (suspect to counting, e.g. 2 houses, 3 machines etc.), or **continuous** (suspect to measurement, e.g. temperature, height. etc.).

Constant and Parameter

A quantity that remains fixed in the context of a given problem or situation is called a **constant.**

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