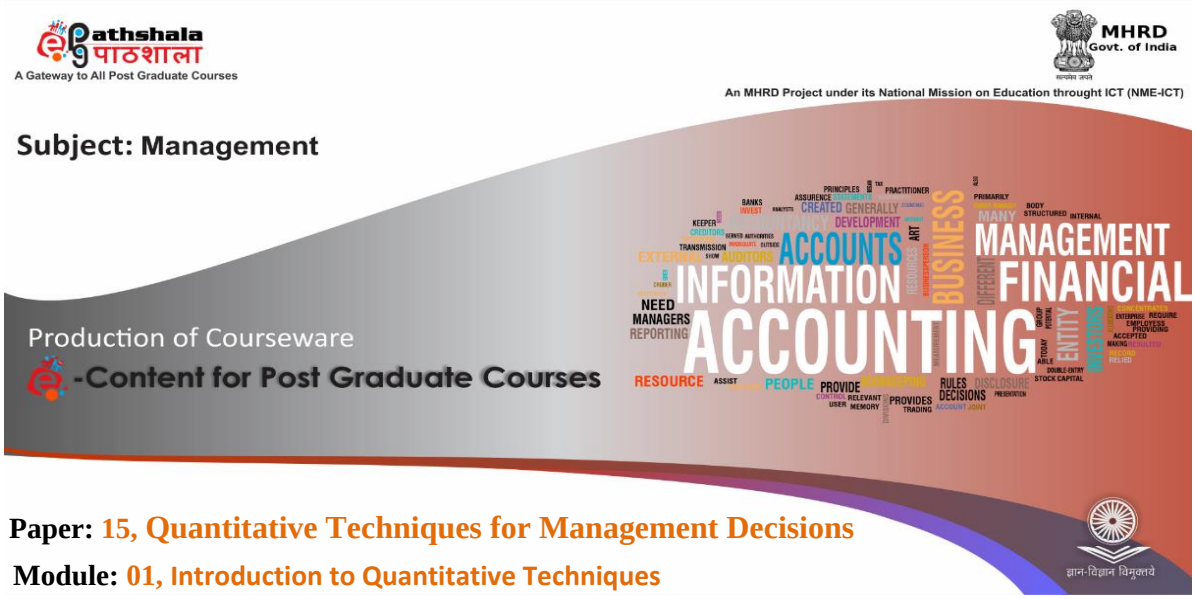

Paper: 15, Quantitative Techniques for Management Decisions

Module: 01, Introduction to Quantitative Techniques

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MHRD Govt. of India

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Items	Description of Module
Subject Name	Management
Paper Name	Quantitative Techniques for Management Decisions
Module Title	Introduction to Quantitative Techniques
Module Id	Module No.-01
Pre- Requisites	Basic understanding of Business Decisions
Objectives	To apprise students about relevance of quantitative techniques in business decision making in today's competitive world
Keywords	Quantitative techniques, Business decision making, statistics

QUADRANT-I

Module-15 Introduction to Quantitative Techniques
1. Learning Outcome
2. Introduction
3. Decision Making basics
4. Role of quantitative techniques in business decision making
5. Classification of quantitative techniques
6. Scope of quantitative techniques
7. Summary

1. Learning Outcome:

After completing this module the students will be able to understand:

- the meaning of quantitative techniques
- basics of decision making
- the relevance of quantitative techniques in business decision making
- the classification of quantitative techniques
- the various quantitative tools available for business decision making

2. Introduction

Quantitative techniques can be understood as a collection of mathematical and statistical tools that are used to provide powerful means of analysis using quantitative data for effective decision making in business. These techniques involve systematics and scientific methods for solving complex problems for taking effective business decisions.

Quantitative techniques involve the use of numbers symbols, mathematical expressions, and other elements of quantities, and serve as supplements to the judgment and intuitions of the decision makers. These tools help businesses in optimum utilization of limited resources.

Traditionally, quantitative techniques are understood by different names such operation research, or management science. More recently, statistical techniques are also understood to have been part of quantitative techniques.

3. Decision making

Decision making pervade all aspects of the business. The verb decide has been derived from Latin prefix 'de' and the word 'caedo' meaning "off" and "to cut" respectively. This led to origin of the word "Decido " or deciduous, referring to those plants the leaves of which fall in the autumn. But that is only one meaning of it. Other word derived from it is "decide" that means "take the plunge" suggesting the meaning of in which making a wrong decision provokes the fear of falling.

As per Drucker long range planning deals with the futurity of present decisions rather than future decisions. Thus it relates present planning and future events. Current decisions should be made keeping in mind the anticipated effect and the outcome of events that influences future values and decisions. Decisions should balance efficiency with flexibility, and existing opportunities to react to future circumstances and needs.

Decision making process

Decision making is systematic process involving several steps such as identifying the problem or issue, identifying decision criteria, allocating weights to decision criteria, generating alternatives, evaluating and choosing an alternative, implementing the decision alternative and finally evaluating if the decision alternative was effective or not. For example, If an organization is deciding to buy laptops for its 500 employees, then it needs to first find out why these laptops are needed, the kind of configuration needed in those laptops, the price, quality, service warranties that different vendors will be charging, evaluating a set of vendors and then take a decision to order from a vendor.

Decision making, Rationality and Bounded Rationality

It is assume that managers make rational decision making by making logical and consistent choices to so as to maximize value. But it may not be possible as right and timely information to make fully rational decisions is not available in most of the situations. The decision of Hewlett-Packard (HP) acquiring Compaq is an example of poor decision making on the part of then CEO, Carly Fiorina who even lost her job as company did no research to discover that customers perceived Compaq products as inferior—just the opposite of what customers felt about HP products—it was too late.

Therefore, making a rational decision may be ideal expectation but not realistic one. A more realistic approach to make decisions is the concept of bounded rationality. As per this concept managers make decisions rationally, but are limited (bounded) by their ability to process information. It is not possible for managers to evaluate all information on all alternatives and therefore most managers take satisficing decision rather than a decision that will maximize his/her gain. That is, they accept solutions that are "good enough."

Role of Intution in decision making

When a manager makes a decision based on his experience, feelings, and accumulated judgment, we may say that he or she is taking decision based on his intuition. Researchers have identified five different aspects of intuition as Experience based decisions, affect-initiated (feeling or

emotion based), Cognitive based decisions, Subconscious mental processing and value or ethics based decisions.

Types of decsisions
Decsision can be structured and programmed or unstructured and non-programmed. When the problems are routine or straitforward we solve them by creatiung rules, procedures or policies etc. But if the problem is unique and complex then we need a detailed analysis to reach to a solution.

Decision Making under Certainty, Risk and Uncertainty
The decision are made under any one of the condition i.e. under Certainiity or Risk or Uncertainity. Under conditions of cenrtainty, a manager makes most accurate decsions as he is aware of outcome of every action beforehand. This is one of the most desirable situation but is mostly unrealistic.
Exactly opposite to it would be decsion making under condtiiion of uncertainty where a manager is not at all aware of possible outcomes of his choice of alternatives. He is not even in a position to make some probable geuss. Here alternatives are chosen by a manager's intution, judgement, hunch and his psychological orientation.
The most common situation faced by managers is one of risk in which the decision maker is able to estimate the likelihood of certain outcomes. Under risk, managers utilizes historical data from secondary sources or from personal experiences and assign probabilities to different alternatives.

4. Role of Quantitative Techniques in Business decision making

Decision making is one of the most fundamental activity in any business and is very crucial for its survival, growth and success. Be it a decision to enter a new market, design a product, hire people, raise funds or decide something similar, all these situations would require a manager to evaluate various available options to choose the best for being effective. Most of the times, these decisions are taken in an environment where there is lack of requisite information and other important resources such as men, money and machine apart from constraints of time, cost and space. This makes decision making very difficult and therefore demands a logical approach to finalize a course of action.

Traditionally, most of the decision were based on intuition, experience and judgment of the decision maker. Using data for taking decision was almost unheard of and therefore, decision taken in that manner were certainly not the most beneficial to an organization. In fact, it was until 19th century when Frederick W. Taylor experimented in factory set up to solve problem of productivity using scientific method. The evolution of industrial engineering, scientific methodologies that were prominent earlier in the natural sciences, were found applicable to management functions-planning, organizing and controlling of operations. Today most of the business decisions are taken with the help of one or many of quantitative techniques available to a manager. Not that quantitative techniques have replaced institution and judgment, rather these techniques have supplemented these to make decisions more effective.

Specifically, these techniques are helpful in managing production by identifying the right site for setting up factory, scheduling the production process correctly, controlling wastage, producing optimum lot sizes & product mix etc.. Further, Human resource management decisions such as manpower planning, methods of recruitment, selection, training, compensation, can also be optimized using these techniques. In marketing too, these techniques can be quite useful in determining right distribution & warehousing points and levels of customer satisfaction. In fact, all 4 P's related decisions in marketing can be taken more effectively using these techniques. Even for finance related decision such as raising funds from appropriate sources, determining policies related to replacement, managing a profit plan, estimating credit and investment risk, quantitative tools are very useful.

5. Classification of Quantitative Techniques

Broadly, there are two types of quantitative techniques- Mathematical and statistical quantitative techniques.

Mathematical quantitative techniques process quantitative data using principles of mathematics. These include wide range of tools such as *Algebra, Set theory, Permutations and combinations, Matrix Algebra, Determinants, Differentiations, Integration, Differential equations* etc. In addition to this, there are several mathematical programming techniques that includes *linear programming, Assignment and Transportation models, dynamic programming, Inventory control, game theory, queuing theory, replacement models, simulations, decision theory, network programming, Sequencing, Quadratic programming, Branch & bound techniques* etc. which are very useful and are widely used to reach at effective business decisions. Most of these mathematical techniques result in decision models that are deterministic in nature.

The second type of quantitative techniques involve statistical enquiry to solve business problems and include variety of statistical tools used for analyzing data for better decision making. This part of quantitative techniques deal with understanding the use of statistics in business decision making. Since decision making is based on information availability, therefore it becomes important that correct and timely information is obtained in the form of well documented data. Many a times, the data may be readily available from secondary data sources but there may be situations where a manager need to generate fresh data from primary sources by carrying out surveys. The decision in this case will include activities ranging from methods of data collection to data analysis. Most of models developed using statistical techniques include probabilistic models of decision making with the presence of random error. These techniques consists of tools such as

a) Data classification, tabulation and presentation

b) Measures of Central tendency
c) Measures of dispersion
d) Probability & probability distributions
e) Sampling and Sampling Distributions
f) Estimation theory
g) Hypothesis Testing and decision making
h) Analysis of Variance (ANOVA)
i) Correlation and Regression Analysis
j) Forecasting using Time-Series analysis
k) Fundamentals of Decision theory

Though statistical techniques also include several multivariate analysis tools but that is beyond the scope of this course.

6. Scope of the course

As discussed in the previous section, there are a large number of quantitative techniques available of business decision making. However, it will beyond the scope of this course to discuss all of them here. For simplicity and practicality, the current course will only cover following topics related to statistical quantitative techniques–

a) **Basic of Business Statistics**

Statistics has been defined as a science dealing with the collection, analysis, interpretation, and presentation of numerical data. (Webster's Third New International Dictionary). Statistics can be classified in two ways – descriptive and inferential statistics. When we use data gathered of a group to describe or reach conclusions about that same group, the statistics are called descriptive statistics. For example, if an instructor gathers information about marks scored by students in his class and summarizes the information that most of students have scored above average and therefore reach to conclusions that class has learnt lesson well, then it will be an example of descriptive statistics. Second type of statistics is called inferential statistics. When a manager or researcher collects data from a sample and uses this sample statistic to reach conclusions about the population characteristic we call it inferential statistics. The data gathered from the sample are used to infer something about a larger group.

b) **Data classification, tabulation and presentation**

Raw data or ungrouped data is generally cumbersome to handle and interpret. Therefore, it is slightly difficult to come out with meaningful information for decision making based on it. In statistics, there are several tools available for summarizing and presenting the data such as frequency distributions, stem-and-leaf plots, histogram, frequency polygons, Ogive curves, box plots, bar chats, pie charts, pareto charts (for single variable) and scatter plots (for two variables)

c) **Measures of Central tendency**

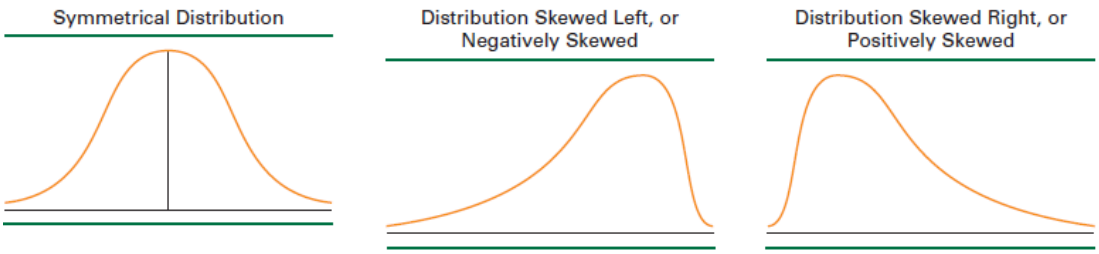
At times we feel the need to describe a given dataset with one single representative value, usually a middle value .For example, a professor of statistics would like to know how his students have fared in Business statistics course. Similarly, a shoe manufacturing company may be interested in knowing which number shoes shall be manufactured in factory to earn maximum profit. In such situations, we need a value that represents a given dataset well enough to enable a manager to make good decision.

This representative central value of a dataset is called as measures of central tendency and can be in the form of Mean, median, mode.. Here mode is *most frequently occurring value in a dataset, median is middle value in an ordered dataset, and mean is the sum of numbers divided by number of values in a dataset.*. One simple way to find this out could be finding out the mean marks of the class in the course.

d) **Measures of dispersion**

These are also known as measures of variability in the dataset. Two most commonly used measures of dispersion are variance and standard deviation. Variance represents average squared deviation of given values from actual mean in the dataset. Standard deviation is calculated as under root of variance. Both of these measures of variability give an idea of shape of frequency distribution. If the values in a dataset are closer to each other i.e. mean, then its variance is likely to be very less. These two measures help in decision making in most of business situations. For example, if there is high variance in the life of a led bulb, then customers are less likely to buy it. Similarly, an IPL team owner is less likely to buy a player if there is a high standard deviation or variance in his batting average.

Skewness and Kurtosis are two other important indicators of dispersion that help us analyze the shape of a frequency distribution curve. A distribution of data in where both halves i.e. right half and left half are mirror images of each other, then it is called as s*ymmetrical*. Normal distribution, or bell shape curve is an one example of a symmetrical distribution. But when the distribution of a data is not symmetric or is asymmetric, it is called as skewed distribution. If the long and thin part of the curve is on the left side, it is called as left or negatively skewed and if it is on right side then it is called as right or positively skewed (fig. below). An Instructors may sometimes refer to a grade distribution as skewed, if few students scored at one end of the grading scale, and many students scored at the other end.



Kurtosis describes the peakedness of the data distribution. Distributions that are high and thin are referred to as **leptokurtic** distributions. Distributions that are flat and spread out are referred to as **platykurtic** distributions. Between these two types are distributions that are more "normal" in shape, referred to as **mesokurtic** distributions.

e) **Probability & probability distributions**

If it is said that there are 90% chances of rain tomorrow, then how is it going to affect planning for tomorrow? May be some of you will carry an umbrella with him/her to office. A cricket match may be rescheduled for future date, an open theatre commercial event may be relocated to new venue, and the route of trucks in a fleet company may be rerouted if the prediction is for very heavy rain. In short, probability affects all of us, almost, in every aspect of our lives. Especially in managerial decision making, it has great utility as most of the business decisions involve a chance factor in their success or failure. *Probability can be understood as a chance of happening or not happening something. Its value always lies between 0 to1 and always expressed in decimals or fractions.*

Probability distributions are theoretical frequency distributions that explain how the outcomes of an event are expected to vary. These distribution are very useful in drawing inferences and making decisions under conditions of uncertainly. Take a case of an investor who would like to invest in a company's stock if it gives him or her a return of 10%. The current cost of each share of this company is 150 Rs. Also assume that through some past analysis he has been able to find the possible return as Rs. 0, 10, 15, 25, 50 with their respective probabilities as 0.20, 0.25, 0.30, 0.15 and 0.10 for the mentioned stock. With the given probability distribution the investor will be able to take a decision to invest or not invest in the company's stock. All he needs to do is compare the required return of Rs. 15 ***(10% of 150 Rs)*** with expected return Rs. 15.75 ***(0 x 0.20 + 10 x 0.25 + 15 x 0.30 + 25 x 0.15 + 50 x 0.10)*** to go in the favor of investing in the stock.

Broadly, probability distributions can be classified as discrete or random. In discrete probability distributions, a random variable can only take discrete probability values. For example, the probability that an individual is born can only take one of the 12 values as there are only 12 months. Though there are many discrete probability distributions but this course will be limited to the discussion of only two widely used discrete probability distributions viz. Binomial distribution and Poisson distribution.

In continuous probability distributions, a random variable can take any value within a given range. Take for example, a business school claims that the average package received by their MBA students is 10 lac per annum with a standard deviation of 1.5 lac p.a. So what is the probability that a student selected at random would be getting a

package of less than 8 lac p.a.. In such a scenario, the continuous distribution will help us find this probability.

Again, there are number of continuous probability distributions but discussion in this course will be limited to normal, z, t and F distributions.

f) **Sampling and Sampling Distributions**

In several situations, it may not be practically possible to study the entire population because of resource constraints. Yet we may be need some information about the population characteristics to take important business decisions. For instance, a big car manufacturing company such as Maruti Suzuki in India may wish to know the satisfaction level of its customers so that it can continue producing cars or bring changes in the existing products. To find this, one of the option available to company is contact all customers, which may be in crores by now, and ask about their satisfaction. It is very much possible but would require lots of money, men and time. Practically, it would be very difficult to hold such kind of study that will include every member of population i.e. customers in the study. In such a scenario, the company always has an option of choosing a small sample of customers and then draw inferences about population satisfaction. There will always be some random error in estimation but with the help of sampling distributions, we can always calculate such probabilities and take faster and efficient decisions. So in nutshell, sampling is a way of choosing a part of population with a purpose of drawing some inferences about population characteristics.

A sampling distributions may be understood as a probability distribution of all possible means of various samples drawn from a population. For example, if we wish to know the average mileage of cars of a company and we have only four cars A, B, C, D, as population. To choose a sample of any two cars, we will have six sample combination of cars (AB, AC, AD, BC, BD, CD). Now if we take mean of mileage of every sample combination and draw their frequency distribution, it will be called a sampling distribution of means.

g) **Estimation theory**

Estimation theory has a lot of relevance in business decision making. A manager working in different capacities would like to estimate one thing or other while taking business decisions –A marketing manager would estimate the demand for its products in forthcoming year, a production manager may estimate the raw material requirements, an HR manager would like to estimate manpower requirements and a finance manager, similarly, would like to estimate fund requirement for next financial year.

Traditionally these decisions were largely based on hunch but now, with the help of quantitative techniques i.e. statistics, we may use estimation theory to reach approximately to a rational decision. Probability theory forms the bases of statistical

inference and this further is based on estimation and hypothesis testing. In other words, we try to estimate the characteristics of a population from a sample in a way that the estimate reflects the true population characteristics to the closest.

Estimates can be made in ways – point estimate and interval estimate. While point estimate is a single number through which we estimate a population parameter, an internval estimate will give a range of values within which a population parameter will fall with some prior calculated probability. For example, if a manager is making a point estimate about demand she or he may come out with a single number such as Rs. 100crore. Whereas, an interval estimate of demand forecast will be a range such as Rs.75 - 125 crores. In former kind of estimation, there is an inherent limitation, as manager's estimate would either be right or it would be wrong with more chance of him being wrong. However, in interval estimates the chance that the manager is right will be quite high.

h) **Hypothesis Testing and decision making**

Testing of hypothesis is an important statistical tool to judge the reliability of inferences drawn on the basis of sample studies

In business, we always make one or other claim about possible situations or outcome of a decision. For example, internal recruitment is more effective source of recruitment, older employees are less efficient, females get lessor salary than males etc.

A hypothesis is an assumption or claim that we make about a population parameter (population mean, standard deviation, and variance). Since most of the times, it is not possible to study whole of population due to time and resource constraints, we make an attempt to estimate a population parameter using a sample statistic (sample mean, standard deviation, and variance). To test the validity of the claim made about a population, a sample data is collected and then find out the difference between hypothesized value and actual value of the sample mean. Then using probability distributions (in this case sampling distribution), we find out if the difference is significant or not. This significant of difference not determined merely by intuition but rather is concluded using statistics.

Imagine a business school claiming that an MBA graduate in their campus gets an average salary of Rs.10 lakhs with a standard deviation of Rs. 10000. To test this claim, you picked up a sample of 49 passed out students and calculated their average salary as Rs.9.95 lakh p.a. By intuition you may always conclude that the difference between a population claim i.e. 10 lakh and sample value i.e. 9.95 lakh is very small i.e. Rs. 5000 so as to treat it as insignificant. However, the result will be otherwise if we use statistics here to accept or reject our hypothesis.

Hypothesis are, conventionally, formulated as Null and Alternate hypothesis. Null hypothesis represents a situation of no change, status quo, no impact or no relationship

between variables of interest. Whereas an alternate hypothesis is exactly opposite of what is there in null hypothesis i.e. a significant change, significant impact or relationship between variables.

Hypothesis testing may be done using several tests such as Z test, T-Test, Paired t test, Independent sample t-test, Chi square test, F-tests etc.

i) **Analysis of Variance (ANOVA)**

Analysis of Variance (ANOVA) is a technique through which we can test the significance of differences among more two sample means simultaneously. In this, the total variation is decomposed into various components corresponding to the sources of variation. Using this technique, we can draw inferences about whether our samples are drawn from the same population or populations having same means.

For instance, an HR manager may like to find out if satisfaction level across three departments (Marketing, Finance and HR) are same or different. The manager may get an average satisfaction score of 7, 6, 8 for Marketing, Finance & HR departments respectively. Now to compare these there mean satisfaction scores, we can use ANOVA technique to test following hypothesis –

H0: All three means are equal

Ha: At least one of the means is different from the others.

Depending upon how many dependent variables, independent variables and extraneous variables we have in our research design we may choose between variety of ANOVA techniques such as One way Anova, Two Way Anova, Factorial Anova, Manova, Anacova etc.

j) **Correlation and Regression Analysis**

In business, there are several situations, when one may find that two variables appear to be related. For example, Motivation at workplace may be related to performance based incentives, Performance may be related to age, gender, educational qualification, work life balance etc. In such cases, a manager always feels a need to know more accurately about these relationships through some tangible quantitative measures. One such quantitative measure in statistics is Correlation.

Correlation describes the degree and direction of relationship among two or more variables. Its value lies between -1 to 1 with values near to 0 indicating a weak correlation and values closer to 1 indicating strong correlation. Though value of correlation coefficient can also take a negative value such as - 0.8 but one should be careful to interpret the negative sign as an indicator of direction of relationship only (Positive or negative relationship) and take absolute value ignoring sign for interpreting strength of relationship between variables of interest.

r =

One the limitation of correlation is that we can always tell that two or more variables are highly or weakly and positively or negatively correlated but we can never say that

variable X is influencing variable Y. For this purpose we have a concept called regression in which we can find out the impact that one variable X may have on other variable Y. Regression, though, can be used for number of purposes in business situations. First, it can check if any relationship exists between a dependent variable and a set of independent variables. Second, it can be also be used to find out the relative importance of various independent variables in impacting dependent variable. Still further, regression can also be used for predicting values of dependent variable Y for a given value of independent variable X.

A simple regression model may be expressed as below -

$$\mathbf{Y = a + bX + u}$$

Here Y = Dependent Variable

X = Independent Variable

a = Intercept i.e. value of Y when X is zero

b = Regression coefficient or parameter to be estimated

k) **Forecasting using Time-Series analysis**

Forecasting is all about predicting future. Be it predicting manpower requirements, raw material requirements, demand for products, fund requirements or predicting some other requirement, forecasting is needed for all kinds of business decision making in organizations. Virtually all functional areas of business, including production, sales, employment, transportation, distribution, and inventory, produce and maintain time-series data.

For prediction, time series forecasting is one of popular technique that makes prediction using data gathered on a given characteristics over a period of time. For instance, sales data of past ten or more years can be used to predict the sales for forthcoming year. Time series forecasting techniques takes into account the changes happening in a characteristics such as sales by examining patterns, trends, cycles etc. over the period of a time. There are various methods available for time series forecasting such as naïve methods, moving average, exponential smoothing, regression trend analysis, and the decomposition of the possible time-series factors,

l) **Fundamentals of Decision theory**

The decision theory deals with those mathematical and statistical approaches that enable a decision maker to evaluate and judge the best available alternative opportunities. Decisions are generally made under three kinds of situations i.e. decision making under certainty, decision making under uncertainty and decision making under risk. Most of the decision problems have three important variables namely decision alternatives, states of nature, and payoffs. Decision alternatives are the options available to a decision maker out of which he or she has to make a choice. States of nature are the situations or conditions that arise after the decision has been made and over which the decision maker has no control. The payoffs are the gains or losses that the decision maker will reap by

exercising various decision alternatives. The three aspects (decision alternatives, states of nature, and payoffs) can be displayed in a table known as payoff table or decision table.

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Yearly returns (payoff) on an Investment of Rs. 10 million

		States of economy		
		Stagnant	***Slow Growth***	***Fast Growth***
Investment alternatives	***Stocks***	-10%	7%	25%
	Bonds	1%	7%	10%
	Mix	-5%	7%	14%

In decisions under certainty, the most elementary of the decision making situations, *the states of nature are known with certainty in advance and decision maker is only required to evaluate the payoff matrix to select an alternative that reaps maximum payoff.*

Decision making under uncertainty happens *when occurrence of states of nature and the probability its occurring is not known*. Hence, the decision maker has no information about which state of nature will occur, and he or she attempts to develop a strategy based on payoffs. Several approaches such as the maximax criterion, maximin criterion, Hurwicz criterion, and minimax regret etc are available to take decision under such conditions.

7. Summary

This module provides the basic understanding of quantitative techniques. Quantitative techniques can be understood as a collection of mathematical and statistical tools that are used to provide powerful means of analysis using quantitative data for effective decision making in business. These tools help businesses in taking effective business decision and hence result in optimum utilization of limited resources. Decision making is systematic process involving several steps such as identifying the problem or issue, identifying decision criteria, allocating weights to decision criteria, generating alternatives, evaluating and choosing an alternative, implementing the decision alternative and finally evaluating if the decision alternative was effective or not. Decision can be structured and programmed or unstructured and non-prgrammed. Broadly, there are two types of quantitative techniques- Mathematical and statistical quantitative techniques. While former includes include wide range of tools such as Algebra, Set theory, Permutations and combinations, Matrix Algebra, Determinants, Differentiations, Integration, Differential equations etc. and several mathematical programming techniques such as linear programming, Assignment and Transportation models, dynamic programming, Inventory control, game theory, queuing theory, replacement models, simulations, decision theory, network programming, Sequencing, Quadratic programming, Branch & bound techniques etc., whereas the latter includes variety of statistical concepts and tools such as Data classification, tabulation and presentation, Measures of Central tendency, Measures of dispersion, Probability & probability distributions, Sampling and Sampling

Distributions, Estimation theory, Hypothesis Testing and decision making, Analysis of Variance (ANOVA), Correlation and Regression Analysis, Forecasting using Time-Series analysis and Decision theory for effective decision making. The current course covers statistical quantitative techniques and excludes mathematical quantitative techniques as it is beyond the scope of this course.`