: CHAPTER - II :

A REVIEW OF LITERATURE

CHAPTER TWO / A REVIEW OF LITERATURE.

2.1 CONSUMERS BEHAVIOUR :

Customer is the central point and all the marketing activities revolve around him. Understanding the buying behaviour of the target market is the essential task of marketing managers under the marketing concept. Manufacturer produces what the customer want. The consumer market consist of all the Individuals and household that buy or acquired goods and services for personal consumption. Consumers very tremendously in age, income, educational level, mobility pattern and taste. So customer behaviour deffer from person to person. Marketers find it useful to distinguish different consumer group and develop products and services tailored to their needs.

According to Webster,

"Buyer behaviour is all Psychological, Social and Psysical behaviour of potential customers as they become aware of evaluate, purchase, consume and tell other people about product and service".

Consumer behaviour is obviously one kind of human behaviour. Since we have defined consumer behaviour as that behaviour encompassed within the exchange of process, the offering of some valuable product or service by one person in return for some kind of valuable product or service by one person in return for some kind of valuable consideration from the other person. Many kinds of human behaviour involve on such interpersonal action, but any kind of social interaction inevitably involves what is called consumer behaviour.

Who is the Consumer ?

There is no distinction between the seller and buyer. Both parties are buying something and both parties are selling something. But in a dynamic sense, there is perceivable difference. The seller is the one who takes the initiative and makes the first offering. The consumer is normally the one who responds to that offering in some way.

In literal terms, the word consumer is a derivative of the verb "to consume", which means to distroy or use up. This would seem to define the consumer as the person who does the final act of ingesting

the food or wearing the clothes. However, the person who chooser the product is also considered to be the consumer.

There are really many types of consumer. Final consumers of personal items, industrial buyer, institutional buyers, agricultural consumers and the unique type of gate-keeper-designer - the professional advisor.

Importance of Study of Consumer Behaviour :

Modern marketing is customer oriented. Therefore the study of Customers behaviour is vital in framing production policies, price policies, decision regarding channels of distribution and above all decisions regarding sales promotion.

1) Production Policies :

The consumer behaviour gives an insight into the various factors which prompt him to purchase and like a particular product. If it is know that it is the packing which attract the buyer then the producer will pay sepecial attention to the packing of his products,

thus consumer behaviour helps a great deal in formulating production policies.

2) Price Policies :

The buyers behaviour is equally important in having price policies. The buyers of some products purchase only because particular article are cheaper than the competitive articles available in the market. In such a case the price of such products cannot be raised. On the other hand, some other articles are purchased because it inhances the prestige and social status of persons. The price of such things can easily be raised. Some articles are purchased under particular attitude and emotions such as Khadi garments; Prices of articles purchased under emotional motives can also be raised.

3) Decision regarding channels of distribution :

The goods which are sold and purchased solely on the basis of low price must have cheap and economical distribution channels. In case of those articles which require service after sale such as T.V.Sets must have different channels of distribution. Thus decision

regarding channel of distribution are taken on the basis of consumer behaviour.

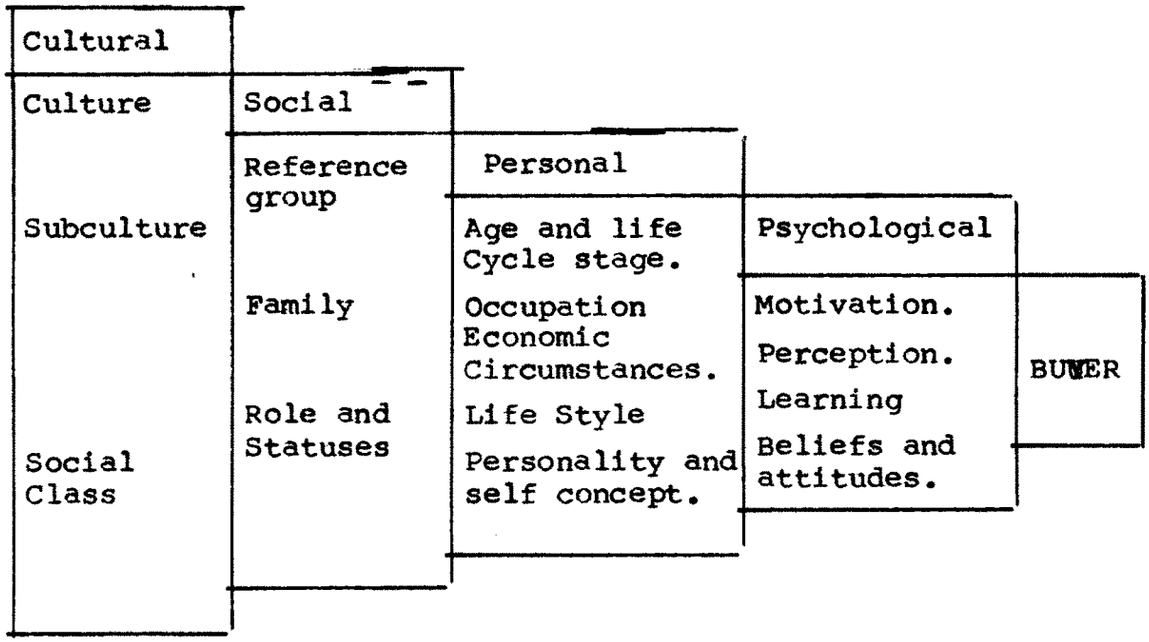
4) Decision regarding Sales promotion :

A study of consumer behaviour is also vital role in making decision regarding sales promotion. It enables the producers to know what motive prompts buyer to make, purchases and the same are utilised in advertising media to awken desire to purchase. The marketer who takes decision regarding brand, packaging, discount, gifts etc.on the basis of consumer behaviour for promoting sales of his products.

Factors Influencing Consumer Behaviour :

A Buyers purchase decisions are highly influenced by the buyers unique set of cultural, social, personal and Psychological factors. These factors are "Non-controllable" by the marketer but must be taken into account. We want to examine each factor's influence on buying behaviour.

Model of Factors Influencing Behaviour:



: Figure No. 2.1 :

Reference : Philip Kotler; "Marketing Management", Analyzing Consumer Markets and Buyer Behaviour, Prentice Hall of India P.Ltd. New Delhi; 1989, P.176.

Cultural Factors :

Cultural Factors exert the broadest and deepest influence on consumer behaviour.

Culture - Culture is the most fundamental determinant of person's wants and behaviour. Whereas lower creatures are largely governed by instinct, human

behaviour is largely learned. The child growing up in a society learns a basic set of values; perceptions, preferences, and behaviour through a process of socialization involving the family and other key institutions.

Subculture - Each culture consists of smaller subcultures that provide more specific identification and socialization for its members. There are four type, of sub culture i.e. Nationality groups, Religious groups, Racial groups and Geographical groups.

Social Class - Social Classes are relatively homogeneous and enduring divisions in a society, which are hierarchically ordered and whose members share similar value, interest and behaviour.

Social Factors :

A consumer's behaviour is also influenced by such social factors as reference groups, family and social roles and statuse.

Reference Groups - Many groups influence a person's behaviour. A person's reference groups consists of all the groups that have a direct or indirect influence

on the person's attitudes or behaviour. These are membership groups, primary groups, secondary groups, includes religious, professional and trade union groups and aspirational groups.

Family - Family members constitute the most influential primary reference group shaping a buyer's behaviour.

Roles and statuses - A person participates in many groups throught life-family, clubs, organisations. The person's position in each group can be defined in terms of role and status. People choose products that communicate their role and status in society. Thus company presidents drive Mercedes, Wear expensive tailored suits, and drink chivas Regal scotch.

Personal Factors :

A buyers decisions are also influenced by his or her personal characteristics, notably the buyers age and life cycle stage, Occupation, economic circumstances, life-style and personality and self concept.

Age and Life-Cycle stage - People change the goods and services they buy over their lifetime. They eat baby food in the early years, most foods in the

growing and mature years and special diets in later years. People's taste in clothes, furniture and recreation is also age related. Consumption is also shaped by the stage of the family life cycle.

Occupation - A person's consumption pattern is also influenced by his or her occupation. A blue collar worker will buy work clothes, work shoes, lunch boxes and bowling recreations. A company President will buy expensive blue-serge suits, air travel, country club membership, and large suilboat. Marketer try to identify the occupational groups that have an above average interest in their products and services.

Economic Circumstances :

Product choice is greatly affected by One's economic circumstances Peoples economic circumstances consist of their spendable income, saving and assets borrowing power and attitude towards spending versus saving.

Life Style - People coming from the same Sub-culture, social class and even occupation may lead quite different life-styles.

Personality and self concept :

Personality is usually described in terms of such truits as self, confidence, dominance, autonomy, difference, sociability, defensiveness and adaptability. Personality can be useful variable in analysing consumer behaviour.

Psychological Factors :

A person buying choices are also influenced by fair major psychological factors - motivation, perception, learning, and beliefs and attitudes. We will explore each factors role in the buying process.

Motivation :

A person has many needs at any given time. Some needs are biogenic. They arise from psysiological states of tension such as hunger, thirst, discomfort. Other needs are psychogenic. They arise from psychological states of tension such as the need for recognition, esteem or belonging. Most of these needs will not be intense enough to motivate the person to act on them immediately. A need becomes a motive. When it is aroused to a sufficient level of intensity. A motive is a need that is sufficiently pressing to drive the person to act. Satisfying the need reduce the felt tension. Psychologist

have developed theories of human motivation. Three of the best known, the theories of Sigmund Freud, Abraham Maslow and Frederick Herzberg.

Perception :

A motivation person is ready to act. How the motivated person acts is influenced by his or her perception of the situation. Two people in the same motivated state and objective situation may act quite differently because they perceive the situation differently. Perception can be defened as "the process by which an individual selects, organises and interpret information inputs to creat a meaningful picture of the world". Perception depends not only on the character of the physical stimuli but also on the relation of the stimuli to the surrounding field and on conditions within the individual.

Learning :

When people act, they learn. Learning describes changes in an individual's behaviour arising from experience. Most human behaviour is learned. Learning theorists say that a persons learning is produced through the interplay of drives, stimuli, Cues, responce and

reinforcement. The practical importance of learning theory for marketers is that they can build up demand for a product by associating it with strong drives, using motivating cues, and providing positive reinforcement. A new company can enter the market by appealing to the same drives that competitors appeal to and providing similar cue configurations because buyers are move likely to transfer loyality to similar brands than to dissimilar brands. Or it might design its brand to appeal to a different set of drives and offer strong cue inducements to switch.

Beliefs and Attitudes :

Through acting and learning, people acquire their beliefs and attitudes. These in turn influence their buying behaviour.

A belief is a descriptive thought that a person holds about something Manufacturers, of course are very interested in the beliefs that people carry in their heads about their products and services. These beliefs make up product and brand images, and people act on their images. If the some of the beliefs are wrong and inhabit purchase, the manufacturer will want to launch a campaign to correct these beliefs.

An attitude describe a person's enduring favourable or unfavourable cognitive evaluations, emotional feeling and action tendencies towards some object or idea. People have attitudes toward almost everything, religion, politics, clothes, music, food and so on. Attitudes put them into a frame of mind of liking or disliking an object, moving toward or away from it.

We can now appreciate the many forces acting on consumer behaviour. A person's purchase choice is the result of the complex interplay of cultural, Social, Personal, and Psychological Factors. Many of these factors cannot be influences by the marketer. They are useful, however, in identifying the buyers who might have the most interest in the product. Other factors are subject to marketer influence and due the marketer on how to develop product, price, place and promotion to attract strong consumer response.

Types of Buying Behaviour :

Consumer decision making varies with type of buying decision. There are great differences between buying a tooth-paste, a tennis racket, a personal computer, and a new car. The more complex and expensive decisions are likely to involve more buyer deliberation and more

buying participants. Assael distinguished four types of consumer buying behaviour based on the degree of buyer involvement in the purchase and degree of differences among brands. The four types are described below:

Four Types of Buying Behaviour:

	High Involvement	Low Involvement
Significant Differences between Brands	Complex buying behaviour.	Variety Seeking buying behaviour.
Few Differences between Brands.	Dissonance-reducing buying behaviour.	Habitual buying behaviour.

Reference : P'hilip Kotler, "Marketing Management", Analysing Consumer Market and behaviour, Prentice Hall of India Ltd; New Delhi, 1989, P. 191.

Complex Buying Behaviour :

Consumers go through complex buying behaviour when they are highly involved in purchase and aware of significant differences existing among brands. Consumers are highly involved in purchase when it is expensive, bought infrequently, risky, and highly self expressive.

Typically the consumer does not know much about the product category and has much to learn. This buyer will pass through a cognitive learning process characterised by first developing beliefs about the product, then attitudes, and then making thoughtful purchase choice.

Dissonance-Reducing Buying Behaviour :

Sometimes the consumer is highly involved in a purchase but sees little difference in the brands. The high involvement is again based on the fact that the purchase is expensive, infrequent, and risky. In this case, the buyer will shop around to learn what is available but will buy fairly quickly because brand difference are not pronounced. After the purchase, the consumer might experience post purchase dissonance because of noticing certain disquicling of the product or heaving favourable things about other product. The consumer starts learning more things and seeks to justify his or her decision to reduce the dissonance.

Habitual Buying Behaviour :

Many products are bought under conditions of low consumer involvement and the absence of significant brand differences. A good example is purchase of salt. Consumers have little involvement in this product

category. They go to the store and reach for the brand. If they keep reaching for the same brand, say Morton salt, it is out of habit, not strong brand loyalty. There is good evidence that consumers have low involvement with most low-cost, frequently purchased products. In these case consumer do not search extensively for information about the brands, evaluate their characteristics, and make a weight decision on which One to buy. Instead they are passive recipients of information as they watch television or see print advertise.

Variety-Seeking Buying Behaviour :

Some buying situations are characterised by low consumer involvement but significant brand differences. Here consumers are often observed to do a lot of brand switching. An example occurs in purchasing cookies. The consumer has some belifs, choose a brand of cookies without much evaluation, and evaluates it during consumption. But the next time, the consumer may reach for another brand out of boredom or wish for a different taste. Brand switching occurs for the sake of variety rather than dissatisfaction.

2.2 MARKETING RESEARCH :

The development of effective marketing strategies is based upon an understanding of the consumer and his behaviour. But consumer behaviour cannot be absolutely measured, nor can one predict with certainly how any group of people will interact. This is one of the problem facing marketing managers. With all of these unpredictable people how are they supposed to make decision based on their probable future behaviour ? Part of this answer lies in marketing research.

Like any other type of research, marketing research is simply a scientific research for knowledge, especially in the areas related to functions of marketing, and research is the process of gathering, recording analysing of critical and relevant facts about any problem in branch of human activity. It indicates critical and searching study and investigation of a problem, a proposed course of action, a hypothesis or a theory.

Marketing research is only is branch of marketing information system. Market means actual and potential customers. Market research is the systematic and intelligent investigation or study of the "Who, what, where, when, why and how of actual and potential buyers".

It deals with research on customer demand e.g. behaviour and attitudes of customers at the market place, analysis of sales data, analysis of market share of a firm, etc. Marketing research is primerly concerned with investigation, analysis and measurement of marketing demand.

Thus - marketing research is a systematic, objective and intensive search for and analysis of the data relevant to the identification and solution of any problem in the field of marketing. It is the application of scientific principles to observational, experimental, historical and survey methods in a careful search for more accurate knowledge of consumer and market behaviour. So that more effective marketing strategis may be developed.

Definition :

The American Marketing Association defines, marketing research as "the systematic, gathering, recording and analysing of data about problem relating to the marketing goals and services."

According to philip Kotler, "Marketing Research is a systematic problem analysis, model building and fact finding for the purpose of improved decision making and control in the marketing of goods and services.

In the words of Crisp, "Marketing research is systematic objective and exhaustive search for and study of all facts relavant to any problem in the field of marketing".

Objectives of Marketing Research :

The objectives of marketing research can briefly be outlined as below:

1) Marketing research is used in the formulation of all marketing plans, Policies, Programmes and procedures.

2) It is employed for evaluation of these plans, policies etc. When they are brought into practice.

3) It is used in reducing and minimising all marketing costs, particularly, selling, advertising, promotion and distribution costs.

4) Marketing problems demanding best solution through marketing research.

5) To provide insurance cover in dynamic economy for the survical and growth of the business.

6) To know about the customers who buy the companies product and the potentially of markets.

7) To know what, why, when, where and how of the customer wants and what mode they prefer.

8) To find out the impact of promotional efforts.

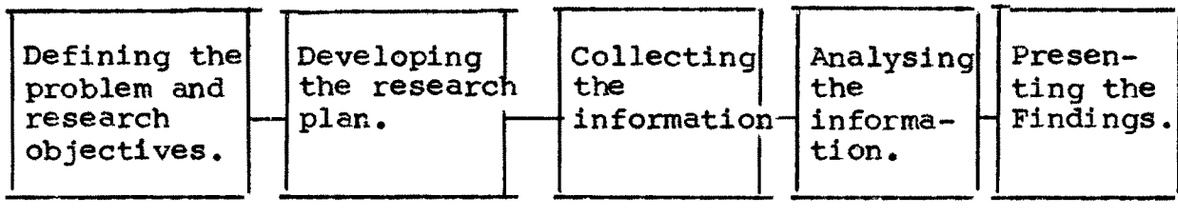
9) To study external forces which are informed about the competitors.

10) To enable manufacturers to make goods acceptable and saleable goods and to see that they search the market more easily, quickly, cheaply and profitably with consumer satisfaction.

Procedure of Marketing Research :

To understand the company's customers, competitors, and dealers, every marketer needs marketing research. The marketing research procedure leads to correct decisions; So the marketer should know enough about marketing research producer.

The marketing Research Process.



: Figure No. 2.2:

Reference - Philip Kotler, Marketing Management, Marketing information system and Marketing Research, Prentice Hall of India P.Ltd; New Delhi, 1989 P.110.

1) Defining the Problem and research objectives -

Defining the problem and reserch objectives carefully is first step of marketing research, Hundreds of things can be reached in any problem. Unless the problem is well defined, the cost of information gathering may well exceed the value of findings. An old adage says,"A problem well defined is half solved". So researcher well lead to solve the problems in proper way and the achievement of objectives.

2) Developing the research Plan -

The second stage of marketing research calls for developing the most efficient plan for gathering the needed information. It is the master plan or model for formal investigation once the formal investigation is decided, the researcher must formulate the formal plan of investigation. This plan concentrates on the selection of sources of information and the selection of the methods

3) Collecting the information :

The research plan can call for gathering secondary data, Primary data, or both. Secondary data consist of information that already exists, somewhere, having been collected for another purpose. The data which is consist of original information for the specific purpose at hand is called primarly data. The data collected is of good quality and sufficient quantity because finding or results of the project depends on the quality and quantity of data collected.

4) Analysing the information -

The next step in the marketing research process is to extract pertinent findings from the data. The resercher Tabulates the data and develops one way and two way frequency distributions. Average and measures of disperation are computed for the major variables. The resercher will attempt to apply some of the advanced statistical techniques and decision model in the analytical marketing system in the hope of discovering additional findings.

5) Presenting the findings -

The last step in marketing research process is to present the research report to the management. The it report must be Written in objective manner and understandable Language, consisting findings and recommendations. The findings and recommendations must be technically accurate and adequatly indicative.

Sampling Plan :

Crisp has defined the sample "If a small number of items or parts called a sample are choosen at the random from a large number of items or a whole called universe or population, the sample will tend to have the same characteristics and to have then in apporximately, than same proportion, as the universe". So sample is only a portion of the universe from which it is drawn.

The marketing researcher must design a sampling plan, which call for three decisions:

1) Sampling Unit - In marketing research, a sample is a particular segment a part of the market and it is focus for taking marketing decision which can be applied to entire market. Sampling unit answers the question, who is to be Surveyed ? The marketing research

must define the target population that will be sampled. The particular sampling unit should be specified. The particular sampling unit is not always obvious.

2) Sample Size - This answers How many people should be Surveyed ? Large samples give more reliable result than small samples. However it is not necessary to sample the entire target group to achive reliable results. Samples of less than 1 percent of population can often provide good reliability, given a creditable sampling procedure.

3) Sampling Procedure - This answers How should the respondent be chosen ? To obtain a representative sample a probability sample of the sample of the population should be drawn. Probability sampling allows the calculation of confidence limit for sampling error. When the cost or time involved in probability sampling is exeessive, marketing researcher will take non-probability samples. Some marketing researchers feel that non probability samples can be very useful in many circumstances, even though the sampling error cannot be measured.

A sampling plan is a vital element of research design. It must indicate sampling unit, sampling size and sampling procedure, means these elements should be properly defined before the process of marketing research and collection of the data.

Data Collection for Marketing Research :

To conduct market research, the necessary information must be gathered. The required information in this connection may be divided into two types. Written and printed records and the information that is obtained in the field. There are two main source of gathering information such as Primary Source and Secondary Source. Secondary data consist of information that already exists somewhere, having been collected for another purpose. The researcher has to gather primary data, which consist of original information for the specific purpose at hand.

Secondary data :

Researcher usually starts their investigation by examining Secondary data to see whether their problem can be partly or wholy solved without collecting costly primary data, The Secondary data is of two types, viz. internal and external.

1) Internal Sources - It includes profit and loss. Statements, Balance sheet, Salesmen's daily report, call report, Sales orders, invoice, inventory, records and prior research reports etc.

2) External Source - The external sources of data are government publications, periodicals and books and commercial data.

a) Government Publications - Much information about the distribution of population, areawise, occupational distribution, number of literates, sex-ratio, number of person professing different religions or speaking different languages, rural and urban composition of population, employment, bank deposits, retail sales etc. Department of Commerce contains economic, market and socialogical data in addition of a count of people. Department of Agriculture is a fine source of information. An agriculture activities. Other government publication includes the annual survey of manufacturer, business statistics, census of manufactures, census of retail trade, Wholesale trade and selected service industry, Census of transpartation, federal reserve bulletin, monthly labour review, survey of current business, etc.

b) Periodicales and Books - Business periodicals index, a monthly, list business articales appearing in a wide variety of business, Publications. Industry survey provides updated statistics and analysis of industries. Marketing journal include, the journal of marketing research and journal of consumer research. Trade magazins includes Advertising age, chain store, age, progressive Grocor, Sales and marketing Management, and stores.

c) Commercial Data - Trade, professional and business associations are able to provide information needed by a researcher. Private research firm, advertising agencies and individual manufacturer of middlemen are also able to provide valuable data required for marketing research.

Primary Data :

After exhausting all the reasonable secondary source of information, resercher may still lack sufficient data. Then they will turn to primary source and gather the facts themselves. The primary data means the information or data collected for the first time during a marketing research. There are three widely used methods of primary data collection, viz, Survey, Observation and

experimentation. Normally, not all three are used on one project. The choice of method will be influenced by the availability of time, money personnel facilities.

(A) Survey Method :

A survey consists of gathering data by interviewing a limited number of people selected from a larger group. Survey work is best suited for descriptive research. Marketing researchers have a choce of two main research instruments in collecting primary data; the questionnaire and machanical devices.

1. Questionnaires - The questionnaire is by for the most common instrument used in collecting primary data. Broadly speaking, a questionnaire consists of a set of questions presented to arespondent for his or her answers. It is very flexible instrument, it needs to be carefully developed, tasted and debugged before they can be administered on a large scale. In preparing Questionnaire, the marketing researcher carefully chooses the questions asked, the form of questions, the wording of the questions and the sequencing of the questions. There are two types of questionnaire, viz; closed-end questionnaire and opened questionnaire. Closed-end questionnaire includes all the possible answers to the questions and the respondent makes

a choice among them. On the other hand, Open-end questionnaire allow the respondent to answer in his or her own words, Open-end questionnaires are especially useful in the exploratory stage of resercher where the investigator is trying to determine how the people thinks in a certain way. Closed-end questionnaires, on the other hand provides answers that are easier to interpret and tabulates.

2. Mechanical Instruments - Mechanical devices are less frequently used in marketing research. The tachistoscope is a device that flashes an ad to a subject with an interval that may range from less than one hundredth of a second to several seconds. The galvanometer picks up the minuts degree of sweating that companies emotional arousal. After each exposure, the respondent describe everything he or she recalls. Eye cameras are used to study eye movement of the respondents to determine at what points their eyes land first, how long. They linger on a given item and so on.

(B) Observation Method :

Observation is the act of recognising and nothing facts or occurrences. For example, instead of asking people to describe what they buy and where from

they buy, researcher arranges to observe what they buy and where from they buy. Naturally, the co-operation of the respondents is not necessary. It is the observe who takes notes of things as they happen. He can avoid many errors due to his personal motivations and plans which cannot be observed. Besides, event of more than short term duration are difficult to observe. Cost of observation is another factor that discourages the observation method.

(C) Experimental Method :

This method of gathering primary data involves the establishment of a scale model or a controlled experiments which stimulates the real market-situation as much as possible. The theory is that the small scale experiment will furnish valuable information in designing a large-scale marketing programme.

The experimental method may be used in several different ways. For example, a firm may manufacture a few units of a product and give them to employees or consumers to try out. The major application of experimental method has been in market testing.

2.3 APPLICATION OF X^2 (Chi-Square) TEST :

Meaning and Definition :

The various of significance such as 't', 'f', and 'z' are based on the assumption that the sample means are normally distributed. These tests are known as 'non-parametric tests'. But there are may situations in which it is not possible to make any rigid assumption about the distribution of the population from which samples are being drawn. This limitation has led to the development of a group of a alternative techiniques known as 'non parametric' or 'distribution free method'. And when non-parametric test are used, no assumption about the parameters of the population(s) from which samples is made. Chi-square test of independence and goodness of fit is a prominent example of the use of non parameter tests. While discussing the study of association in main feld (various) classification, the value of chi-square test is used to study the difference of the observed (actual) and expected frequences. It is very obvious that the importance cf such measure wbuld be very great in sampling studies where we have constantly to study the difference between theory and fact. Thus, Chi-Square test is defined as "A measure of actual difference between observed and expected frequencies". In the sampling studies,

We never expect that there will be perfect coincidence between actual and observed frequencies and the problem that we have to tackle is about the extent to which the difference between actual and observed frequencies can be ignored as arising due to fluctuations of sampling.

As we have seen, Chi-square is a measure of actual difference between expected and observed frequencies and as such, if there is no difference between the observed of expected frequencies, the value of chi-square is o (zero). If there is difference between observed and expected frequencies, the value of chi-square would be more than zero. But difference in the explained observed frequencies may also be due to fluctuation of samples and value of chi-square may arise due to sampling fluctuations and it should be ignored in drawing conclusions. Such value of Chi-square under different conditions are usually available in the shape of table indicates the difference between expected and observed frequencies is not solely due to the sampling fluctuations and that there is some other reason for it. On the other hand if the calculated value of chi-square is less than the table value it indicates that the difference between actual and observed frequencies may

have arisen due to chance fluctuations and can be ignored. In this way, Chi-square test enable us to find out whether the difference between theory and fact or between expected and actual frequencies is significant or not. If the calculated value of chi-square is very small as compared to its table value, it indicatesed that the difference between actual and expected frequencies is very little and consequently, the fit is good. On the other hand, if the calculated value of chi-square is very big as compared to its table value, it indicates that difference between expected and observed frequencies is very great and consequently, the fit is poor.

Essence of Chi-Square Test :

Due to limitation of parametric tests, the theory of non-parametric test developed in the middle of the Nineteenth Century, it was only after 1945 that non-parametric test came to be used widely. Originated in sociological and psychological research, today these tests are very popular in behavioural sciences. It is only because the complexity and limitations of parametric tests. As pointed out by Robert Parket, the following

three reasons accounts for increasing use of non-parametric tests in business research.

1) The statistical tests are distribution-free (can be used with any shape of population distribution).

2) They are usually computationally easier to handle and understand than parametric tests and

3) They can be used with types of measurements that prohibit the use of parametric tests.

Formula :

The X^2 test (pronounced as Chi-square tests) is one of the simplest and most widely used non parametric tests in statistical work. The Greek letter X^2 was first used by karl person in the year 1900. The quantity X^2 describes the magnitude of the discrepancy between theory and observation. As per the definition of chi-square, it is formulated as

$$X^2 = \frac{(O-E)^2}{E}$$

Where 'O' refers to observed frequencies and 'E' refers to expected frequencies.

Steps Required to Determine the value of X^2

The required steps to determine the value of X^2 are --

1. Calculate the expected frequencies.
2. take the difference between observed and expected frequencies and obtain the square of these differences, that is obtain the value of $(O-E)^2$.
3. Divide $(O-E)^2$ obtained in stage (2) by the respective expected frequency and obtain the total $\frac{(O-E)^2}{E}$. This given value of X^2 which can range from zero to infinity. If X^2 is zero, it means that the observed and expected frequencies are completely coincident.

The greater the discrepancy between the observed and expected frequencies, greater shall be the value of X^2.

The calculated value of X^2 is compared with the table value of Chi-square for given degree of freedom at a certain specified level of significance. If the

stated level the calculated value of X^2 is more than the table value of X^2, the difference between theory and observation is considered to be significant i.e. it could not have arisen due to fluctuations of sampling. If, on the other hand, the calculated value of X^2 is less than the table value, the difference between theory and observation is not considered as significant i.e. it is regarded as due to fluctuations of sampling and hence ignored.

It should be noted that the value of X^2 is always positive and its upper limit is infinity. Also, since X^2 is derived from observation, it is a statistic and not a parameter. The X^2 test is, therefore, termed non-parametric. It is one of the great advantage of this test that it involves no assumption about the form of the original distributions from the observations.

Degree of Freedom :

While comparing the calculated value of X^2 with the table value, we have to determine the degree of freedom. The term 'degree of freedom' refer to number of 'independent constraints' in a set of data. For example, if we are to choose any five numbers whose total is 100.

We can exercise our independent choice for any five numbers only, the fifth number is fixed by virtue of the total being 100 as it must be equal to 100 minues the total of the four numbers selected. For example, if the four numbers are 20, 35, 15, 10. The fifth number must be (100-(20+35+15+10) = 20. Thus through were to choose any five numbers, we could choose any four only. Our choice was reduced by one because of one condition placed in the data i.e. that of total being 100. Thus there was only one restraint in our freedom. Our degree of freedom were only four. If more restrictions are placed, our freedom to choose will be still curtailed. For example, if there are 10 clauses and we want our frequencies to be distributed in a such manner that the number of cases, the mean and standard deviation agree with original distribution, we have three constraint and so three degree of freedom are left. Hence, in this case, the degree of freedom will be 10-3=7. Thus, the number of degrees of freedom is obtained by subtracting from the number of classes of the degrees of freedom lost in fitting, symbolically, the degree of freedom are denoted by the symbole V or diF (degree of freedom).

In a contingency table, the degrees of freedom are calculated by the formula V(c-1) (r-1) , Where V = degree of Freedom, C = number of columns and r = number of rows.

The frequencies place the limit on our choice of selecting cell frequencies. The cell frequencies of all columns but one (c-1) and all rows but one (r-1) can be assigned arbitrarily so the number of degrees of freedom for all the cell frequencies (c-1) (r-1). Thus in a (2 x 2) table, the degree of freedom = (2-1) (2-1) = 1. Having filled one cell in such a table, the rest of frequencies automatically follow. There is no choice for them. Similary, in (3x3) contingency table, the number or degrees of freedom is (3-1) (3-1) = 4, and so on. It means only four expected frequencies need be computed. The others are obtained by subtraction from normal totals.

Level of Significance :

As we have mentioned earlier that the observed value of chi-swuare are compared with the table values, to conclude whether the difference between actual and observed frequencies is due to the sampling fluctuations and as such insignificant or whether the difference is

due to some other reason and as such significant. The attributes and sampling of variables are differs of theory and facts always tested in terms of certain possibilities. The possibility indicates the extent of reliance that we can place on the conclusion drawing. This technique is in chi-square are available at various possibility levels. These level, are called as level of significance. Generally, two types of table are available, one in which the probability of a particular calculated value of X^2 for given degree of freedom arising due to chance fluctuations is given and the other in which the independent value of x^2 for given degree of freedom at a certain level of probability are given. By independent value of X^2 means value of X^2 which can aries due to chance fluctuations. Thus, we analyse our result in two ways. In the first method, we find out the probability of observed values of X^2 arising due to chance fluctuation and see whether the probability is high or low. Usually, the value of probability is 0.05 or more it is considered significant which means that if the value of probability is 0.05 or more than the difference is not significant and can be ignored. If the value of probability is one, it indicate that there is absolutely no difference between accepted and actual frequencies. If the value of probability is less than 0.05, it is generally considered

to be insignificant and the conclusion in such cases is that the difference between actual and observed frequency significant and could not have arisen due to chance fluctuations. In the second method, We can find out from the tables the independent value or X^2 at certain level of significance. Usually, the value of X^2 at 5% level of significance for the given degree of freedom is seen from the tables and if the calculated value of X^2 is more than the table value, it means that the difference is significant and if it is less, it indicates the difference could have arisen due to chance fluctions and as such can be ignored. The second method is more convenient and easy and is generally used.

Conditions for Applying X^2 Test :

The following conditions should be satisfied before applying the X^2 test.

1. In the first place, N must be reasonably large. When N is small the probability given by the X^2 test is too small, with the result that the X^2 test might lead to a hypothesis being discredited whereas the exact procedure might cause one not to discredit a hypothesis. It is difficult to say exactly what constitues largeness,

but as an arbitrary Figure. We may say that N should at least 50, however few the cells.

2. No theoretical cell frequency should be small. Here again it is hard to say what constitutes smallness but 5 should be regarded as the very minimum and 10 is better. In practice data not infrequently certain cell frequencies below these limits. As a rule, the difficulty may be met by amalgamating such cells into a single entitled '10 and over'.

3. The constraints must be linear.

Uses of X^2 Test :

X^2 test is one of the simplest and the most general tests known. It is applicable to very large number of problems in practice which can be summed up under the following heads.

1. X^2 Test as Test of Independence :

With the help of X^2 test, we can find out whether two or more attributes are associated or not. Suppose we have N observations classified according to some attributes. We may asked whether the attributes are related or independent. Thus, We can find out whether quinine is effective in controlling fever or not, Whether

there is any association between marriage and failure, or eye colour of husband and wife. In order to test whether or not the attributes are associated. We take the null hypothesis that there is no association in the attributes under study or in other words, the two attributes are independent. If the calculated value of X^2 is less than the table value at a certain level of significance (generally 5 % level), We say that the result of the experiment provides no evidence for doubting the hypothesis or in other words, the hypothesis that the attributes are not associated holds good. On the other hand, if the calculated value of X^2 is greater the table value at certain level of significance. We say that the result of experiments do not support hypothesis or in other words, the attributes are associated. It should be noted that X^2 is not a measure of the degree or form of relationship. It only tells us Whether two principles of classification are significantly related or not related, without reference to any assumptions concerning the form of relationship.

2. <u>X^2 Test as a Test of Goodness of Fit</u> :

X^2 test is very popularly known as goodness of fit, because it tells us how good the fit is of the expected and observed frequencies. If the calculated

value of X^2 is less than the table value at a certain level of significance (generally 5% level), the fit is considered to be good, that is the difference the actual and expected frequencies is attributed to fluctuations of simple sampling. On the other hand, if the calculated value of X^2 is greater than the table value, the fit is considered to be poor, i.e. it cannot be attributed to fluctuations of simple sampling rather it is due to the inadequate of the theory to fit the observed facts.

3. X^2 Test as Test of Homogeneity :

The X^2 test of homogeneity is an extension of the chi-square test of independence. Test of homogeneity are designed to determine whether two or more independent random samples are drawn from the same population or from different population. Instead of one sample as we use with independence problem, we shall now have 2 or more samples. For example. We may be interested in finding out whether Or not University students of various levels, i.e. undergraduate, Post-graduate, Ph.D. feel the same in regard to the amount of work required by their professors, i.e. too much, right amount of work or too little work. We shall take the hypothesis that three samples came from the same population, that is the three classifications are

homogenous in so far as the opinion of three different groups of students about the amount of work required by their professors is concerned. This also means there exists no difference in opinion among three classes of people on the issue.

It should be noted that in both the types of tests, i.e. test of independence and homogeneity, are considered with cross-classification data. The same testing statistic used for tests of independence is used for tests of homogeneity. These two types of test are, however, different in a number of ways. First, they are associated with different kinds of problems Tests of independent are concerned with the problem of whether one attribute is independent of another, While test of homogeneity are concerned with whether different samples come from the same population. Secondly, the former involves a single sample taken from population, but the latter involves two or more independent samples. One from each of the possible population in question.

Limitation on the use of X^2 Test :

X^2 test is very widely used in practice. However, in order to avoid the misapplication of the test, its following limitations should be kept in mind.

1) Frequencies of non-occurrence should not be omitted binomial Or multinominal events. For example, if 5 drugs were tried out 5 separate groups of 200 patients each, the number of cures per drug might be shown in one way table as follows :

	Data for five drugs					
	1	2	3	4	5	Total
Number Cured	80	120	40	60	20	320

However, the X^2 test should not be applied to these data until the alternative outcome, (i.e. not cured) is represented in the table.

2) The Formula presented for X^2 statistics is in terms of frequencies. Hence, an attempt should not be made to computer on the basis of proportions or other derived measures.

3) The formula presented in this chapter is not appropriate for cases in which repeated measurements on the same or matched group are represented in one table when data from questionnaries and similar devices are analysed, the reader should be careful that he doesnot set up the tables incorrectly. For example, it may seen reasonable to set up a table as follows :

	Agree	Neutral	Disagree	Total
Item X	140	190	170	500
Item Y	180	150	170	500

However, a X^2 contigency test should not be performed on the basis of this table. Since it is not really a contingency table, because each student is classified twice in the table.