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Unit-1 / Topic

Topic- Quantitative MethodsS

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Reference Books

1. Book-1 – QUANTITTATIVE METHODS, AUTHOR; DR. RAJESH SAHU, PUBLICATION - ARRISON PUBLICVATION, BHOPAL, EDITION -I, 2023
2. Book-2 = QUANTITTATIVE METHODS, AUTHOR DR S P GUPTA, PUBLICATION - SULTANCHAND & SONS, NEW DELHI

Unit I

The word "Statistics" has been derive from the Latin word "Status" or Italian word "Statista" or German word "Statistika". Each of these words means Political State. Initially, Statistics was used to collect the information of the people of the state about their income, health, illiteracy and wealth etc.
But now a day, Statistics has become an important subject having useful application in various fields in day to day life.
Statistics in Plural Sense:--
In the plural sense, Statistics refers to information in terms of numbers or numerical data such as Population Statistics, Employment Statistics etc. However any numerical information is not statistics. Example: Ram gets ₹100 per month as pocket allowance is not Statistics. It is neither an aggregate nor an average. Whereas average pocket allowance of the students of Class X is ₹100 per month and there are 80 students in class XI & 8 students in Class XII are Statistics.
The following table shows a set of data that which is Statistics and which is not Statistics.
Data which are not Statistics Data which are Statistics A cow has 4 legs. Average height of the 26 plus male people in India is 6 feet compare to 5 feet in Nepal. Ram has 200 rupees in his pocket. Birth rate in India is 18 per thousand compare to 8 per thousand in USA. A young lady was run over by a speeding truck at 100 km per hour. Over the past 10 years, India has won 60 test matches in cricket and lost 50.

From above information we can say that "All Statistics are data, but all data are not Statistics"
Definition:- According to Bowley - "Statistics are numerical statements of facts in any department of enquiry placed in relation to each other."

According to Yule and Kendall ----- "By Statistics we mean quantitative data affected to marked extent by multiplicity of causes."
Characteristics of Statistics in Plural Sense
Main characteristics of Statistics in terms of numerical data are as follows: (1) Aggregate of Facts – A single number does not constitute Statistics. We can not draw any conclusion from single number. We can draw any conclusion by the aggregate number of facts. For example, if it is stated that there are 1,000 students in our college then it has no significance. But if it is stated that there are 300 students in arts, 400 students in commerce and 300 in science in our college. It makes statistical sense as this data convey statistical information. Similarly if it is stated that population of India is 130 crore or the value of total exports from India is ₹11, 66,439 crore then these aggregate of facts will be termed as Statistics. (2) Numerically Expressed - Statistics are expressed in terms of numbers. Qualitative aspects like small or big, rich or poor etc. are not statistics. For instance if we say that Irfan Pathan is tall Sachin is short then this statement has no statistical sense. However if it is stated that height of Irfan Pathan is 6 ft and 2 inch and the height of Sachin is 5 ft and 4 inch then these numerical will be called Statistics. (3) Affected by Multiplicity of Causes – Statistics are not affected by any single factor but it is affected by many factors. For instance 30% rise in prices may have been due to several causes like reduction in supply, increase in demand, shortage of power, rise in wages, rise in taxes, etc. (4) Reasonable Accuracy - A reasonable degree of accuracy must be kept in view while collecting statistical data. This accuracy depends on the purpose of investigation, its nature, size and available resources. (5) Pre-determined Purpose - Statistics are collected with some pre-determined objective. Any information collected without any definite purpose will only be a numerical value and not Statistics. If data pertaining to the farmers of a

village is collected, there must be some pre-determined objective. Whether the statistics are collected for the purpose of knowing their economic position or distribution of land among them or their total population. All these objectives must be pre – determined. (6) Collected in a Systematic Manner – Statistics should be collected in a systematic manner. Before collecting the data, a plan must be prepared. No conclusion can be drawn from data collected in haphazard manner. For instance, data regarding the marks secured by the students of a college without any reference to the class, subject, examination, or maximum marks, etc will lead no conclusion.

Statistics in Singular Sense

In a singular sense, statistics means science of statistics or statistical methods. It refers to techniques or methods relating to collection, classification, presentation, analysis and interpretation of quantitative data. Definition ------ Statistics may be defined as the collection, presentation, analysis and interpretation of numerical data. ---------- CROXTON AND COWDEN ------Statistics is the science which deals with the collection, classification and tabulation of numerical facts as a basis for the explanation, description and comparison of phenomena. ---------- LOVITT

Subject Matter of Statistics

Subject matter of statistics includes two components: 1. Descriptive Statistics 2. Inferential Statistics 1. Descriptive Statistics: Descriptive Statistics refers to those methods which are used for the collection, presentation as well as analysis of data. These methods relate measurement of central tendencies, measurement of dispersion, measurement of correlation etc. For Example: Descriptive statistics is used when you estimate average height of the secondary students in your school. Descriptive statistics is also used when you find the marks in science and mathematics of the students in all classes are intimately related to each other. 2. Inferential Statistics: Inferential Statistics refers to all such methods by which conclusion are drawn related to the universe or population on the basis of a given sample. For example: If your class teacher estimate average weight of the entire class on the basis of average weight of only a sample of sample of students of the class then we use the inferential statistics.

Important terminology in statistics
1. Population: By population we mean a well defined set or group of all the objects for a particular study. The objects may be persons, plants, books, fishes in ponds, shops etc. the population will consist of certain elements like the plants of a certain kind in a specified field, the fishes in a pond, the unemployed person in India, books in library and so on. For instance, if we want to study the properties of students in a school then the population consists of all the students of school. For instance if we want to study about the books in a library then the population includes all the books of the library etc. if the number of elements are limited then the population is finite. On the other hand if the

number of elements is not limited then the population is infinite. Mostly we deal with finite population.

2. Sample: It is a part of the population selected by some sampling procedure. The process of selection of sample is known as sampling. The number of objects in the sample is called the size of the sample. It is believed that a sample is best representative of the population.

For instance, suppose a research worker is required to study the weight of fishes in a pond after a particular period of growth. For this purpose suppose that there are 3,000 fishes in the pond, he may either measure the weight of all the fishes in the pond or he may decide to select a small group of fishes and measure their weights. The first approach of measuring the weight of all fishes is called complete enumeration or census. Another approach in which only a small group of fishes is considered is called sample survey. In brief we can say that in complete enumeration, information is collected on all the units of the universe and in sample survey, only a part of the universe is considered. 3. Variable: A property of objects is known as variable which differ from object to object and is expressible numerically, in terms of numbers. For instance: the marks in Mathematics of students in a class can be expressed in the term of marks obtained by the students. So it is a variable property which is expressible quantitatively. 4. Attribute: A property and characteristic of objects is known as attribute which are not expressible quantatively in number. We can express the data qualitatively. For example, smoking, color, honesty etc.

CHARACTERISTICS OF STATISTICS

1. Statistics are aggregate of facts. 2. Statistics are numerically expressed. 3. Statistics are affected to a marked extent by multiplicity of causes. 4. Statistics are either enumerated or estimated with reasonable standard of accuracy 5. Statistics are collected in a systematic manner. 6. Statistics are collected for a pre-determined purpose. 7. Statistics should be placed in relation to each other. In the absence of the above characteristics numerical data can't be called Statistics and hence "all statistics are numerical statements of facts but all numerical statements of facts are not statistics." According to above Definitions, Statistics is both a science and an art. It is related to the study and application of the principles and methods applicable in the collection,

presentation, analysis, interpretation and forecasting of data. Or statistical facts influenced by several factors and related to any area of knowledge or research so that concrete and intelligent decisions may be taken in the phase of uncertainty

NATURE OF STATISTICS

Statistics as a science: science refers to a systematized body of knowledge. It studies cause and effect relationship and attempts to make generalizations in the form of scientific principles or laws. "Science, in short, is like a light house that gives light to the ships to find out their own way but doesn't indicate the direction in which they should go." Like other sciences, Statistical Methods are also used to answer the questions like, how an investigation should be conducted. In what way the valid and reliable conclusions can be drawn? Statistics is called the science of scientific methods. In words of Croxton and Cowden, "Statistics is not a science, it is scientific methods."According to Tippet, "as science, the statistical method is a part of the general scientific method and is based on the same fundamental ideas and processes."

Statistics as an art: we know that science is a body of systematized knowledge. How this knowledge is to be used for solving a problem is work of an art. An art is an applied knowledge. It refers the skill of handling facts so as to achieve a given objective. It is concerned with ways and means of presenting and handling data, making inferences logically and drawing relevant conclusion. Art

aspects of statistics tell, 'how to use statistical rules and principles to study the problems and finding their solutions. 'Collections of statistics (data) its use and utility are itself an art.
Statistics is both science and art: After studying science and art aspects of statistics, it is used not only to gain knowledge but also to understand the facts and draw important conclusions from it. If science is knowledge, then art is action. Looking from this angle statistics may also be regarded as an art. It involves the application of given methods to obtain facts, derive results and finally to use them for devising action.
STAGES IN A STATISTICAL INVESTIGATION 5 stages -

1. Collection: This is the primary step in a statistical study and data should be collected with care by the investigator. If data are faulty, the conclusions drawn can never be reliable. The data may be available from existing published or unpublished sources or
Collection Organisation Presentation
Analysis Interpretation

else may be collected by the investigator himself. The first hand collection of data is one of the most difficult and important tasks faced by a statistician. 2. Organization: Data collected from published sources are generally in organized form. However, a large mass of figures that are collected from a survey frequently needs organization. In organizing, there are 3 steps as (A) Editing (B) Classify (C) Tabulation. (A) Editing: The collected data must be editing very carefully so that the omissions, inconsistencies irrelevant answers and wrong computation in the returns from a survey may be corrected or adjusted. (B) Classify: Classification is the process of arranging the data according to some common characteristics possessed by the items constituting the data. (C) Tabulation: To arrange the data in columns and rows.
Hence collected data is organized properly so that the desire information may be highlighted and undesirable information avoided.
3. Presentation: Arranged data is not capable to influence a layman. Thus, it is necessary that data may be presented with the help of tables, diagrams and graphs. By these devices facts can be understood easily. 4. Analysis: A major part of it is developed to the methods used in analyzing the presented data, mostly in a tabular form. For this analysis, a number of statistical tools are available, such as averages, correlation, regression etc. 5. Interpretation: the interpretation of a data is a difficult task and necessitates a high degree of skills and experience in the statistical investigation because certain decisions made on the basis of conclusions drawn.

SCOPE OF STATISTICS
In early stages, the scope of statistics was very limited. It was confined mainly to the administration of government and was, therefore, called the 'Science of Kings'. But in modern time, the scope of statistics has widened usually all those facts come in the purview of statistics, which are expressed in quantitative terms directly or indirectly. That is why Croxton & Cowden observed, "Today there is hardly a phase of endeavor which does not find statistical devices at least occasionally useful." It is not unfair to say, science without statistics bears no fruit and statistics without science have no root." The applications of statistics are so numerous that it is often remarked, "Statistics is what statisticians do." Now let us examine a few fields or areas in which statistics is applied.

1. Statistics and the State: in recent years the functions of the state have increased tremendously. The concept of the state has changed from that of simply maintaining law and order to that of a welfare state. Statistical data and statistical methods are of great help in promoting human welfare. The government in most countries is the biggest collector and user of statistical data. These statistics help in framing suitable policies. 2. Statistics in Business and Management: with growing size and increasing competition, the problems of business enterprises have become complex. Statistics is now considered as an indispensable tool in the analysis of activities in the field of business, commerce and industry. The object can be achieved by properly conducted market survey and research which greatly depends on statistical methods. The trends in sales and production can be determined by statistical methods like time-series analysis which are essential for future planning of the phenomena. Statistical concepts and methods are also used in controlling the quality of products to satisfaction of consumer and the producer. The bankers use the objective analysis furnished by statistics and then temper their decisions on the basis of qualitative information. 3. Statistics and Economics: R.A.Fisher complained of "the painful misapprehension that statistics is a branch of economics." Statistical Data and methods are of immense help in the proper understanding of the economic problems and in the information of economic policies. In the field of exchange, we study markets, law of prices based on supply and demand, cost of production, banking and credit instruments etc. The development of various economic theories own greatly to statistical methods, e.g., 'Engel's law of family expenditure', 'Malthusian theory of population'. The impact of mathematics and statistics has led to the development of new disciplines like 'Econometrics'' and 'Economic Statistics'. In fact, the concept of planning so vital for growth of nations would not have been possible in the absence of data and proper statistical analysis. 4. Statistics and Psychology and Education: Statistics has found wide application in psychology and education. Statistical methods are used to measure human ability such as; intelligence, aptitude, personality, interest etc. by tests. Theory of learning is also based on Statistical Principles. Applications of statistics in psychology and education have led to the development of new discipline called 'Psychometric'. 5. Statistics and Natural science; Statistical techniques have proved to be extremely useful in the study of all natural sciences like biology, medicine, meteorology, botany etc. for example- in diagnosing the correct disease the doctor has to rely heavily on factual data like temperature of the body, pulse rate, B.P. etc. In botany- the study of plant life, one has to rely heavily on statistics in conducting experiments about the plants, effect of temperature, type of soil etc. In agriculture- statistical techniques like 'analysis of variance' and 'design of experiments' are useful for isolating the role of manure, rainfall, watering process, seed quality etc. In fact it is difficult to find any scientific activity where statistical data and methods are not used.

6. Statistics and Physical Science: The physical sciences in which statistical methods were first developed and applied. It seems to be making increasing use of statistics, especially in astronomy, chemistry, engineering, geology, meteorology and certain branches of physics. 7. Statistics and Research; statistics is indispensable in research work. Most of the advancement in knowledge has taken place because of experiments conducted with the help of statistical methods. Statistical methods also affect research in medicine and public health. In fact, there is hardly any research work today that one can find complete without statistical methods. 8. Statistics and Computer: The development of statistics has been closely related to the evolution of electronic computing machinery. Statistics is a form of data processing a way of converting data into information useful for decision-making. The computers can process large amounts of data quickly and accurately. This is a great benefit to business and other organizations that must maintain records of their operations.

Processing of row data is extensively required in the application of many statistical techniques.
CLASSIFICATION OF STATISTICS
Statistics can be divided into 3 parts;

1. Descriptive Statistics: Descriptive statistics is related to numerical data or facts. Such data are collected either by counting or by some other process of measurement. It is also related to those methods, includes editing of data, classification, tabulation, diagrammatic or graphical presentation, measures of central tendency, measures of dispersion, correlation etc., help to make the description of numerical facts simple, systematic, synoptic understandable and meaningful. 2. Inferential Statistics: Inferential statistics help in making generalizations about the population or universe on the basis of study of samples. It includes the process of drawing proper and rational conclusion about the universe. Among these methods, probability theory and different techniques of sampling test are important. 3. Applied Statistics; It involves application of statistical methods and techniques to the problems and actual facts. For example-statistics related to national income, industrial and agricultural production, population, price etc. are called applied statistics. It can be divided into 2 parts-(1) Descriptive Applied Statistics- it deals with the study of the dat
DESCRIPTIVE STATISTICS INFERENTIAL STATISTICS APPLIED STATISTICS

which are known and which naturally relate. Its main object is to provide descriptive information either to the past or to the present for any area. For example- price index number and vital statistics comes under the category of descriptive applied statistics. (2) Scientific Applied Statistics- under this branch of statistical science, statistical methods are used to formulate and verify scientific laws. For example-an effort is made by an economist to establish the law of demand, quantitative theory of money, trade circle etc. These are established and verify by the help of scientific applied statistics.
IMPORTANCE OF STATISTICS
In recent days, we hear talking about statistics from a common person to highly qualified person. It only show that how statistics has been intimately connected with wide range of activities in daily life. They realize that work in their fields require some understanding of statistics. It indicates the importance of the statistics. A.L.Bowley says, “Knowledge of statistics is like knowledge of foreign language or of algebra. It may prove of use at any time under any circumstances”.
1. Importance to the State or Government; In modern era, the role of state has increased and various governments of the world also take care of the welfare of its people. Therefore, these governments require much greater information in the form of numerical figures. Statistics are extensively used as a basis for government plans and policies. For example-5-years plans are framed by using reliable statistical data of different segments of life. 2. Importance in Human Behavior; Statistical methods viz., average, correlation etc. are closely related with human activities and behavior. For example-when a layman wishes to purchase some article, he first enquiries about its price at different shops in the market. In other words, he collects data about the price of a particular article and aims at getting idea about the average of the prices and the range within which the price vary. Thus, it can be concluded that statistics play an important role in every aspect of human activities and behavior. 3. Importance in Economics; Statistics is gaining an ever increasing importance in the field of economics. That is why Tugwell said, “The science of economics is becoming statistical in its method.” Statistics and economics are so interrelated to each other that the new disciplines like econometrics and economic statistics have been developed. Inductive method of generalization used in economics, is also based on statistical principle. There are different segments of economics where statistics are used-

(A) Consumption- By the statistics of consumption we can find the way in which people in different group spend their income. The law of demand and elasticity of demand in the field of consumption are based on inductive or inferential statistics.
(B) Production- By the statistics of production supply is adjusted according to demand. We can find out the capital invested in different productive units and its output. The decision

about what to produce, how much to produce, when to produce is based on facts analyzed statistically.
(C) Distribution- Statistics play a vital role in the field of distribution. We calculate the national income of a country by statistical methods and compare it with other countries. At every step we require the help of figures without them. It is difficult to move and draw inferences.
4. Importance in Planning; for the proper utilization of natural and manual resources, statistics play a vital role. Planning is indispensable for achieving faster rate of growth through the best use of a nation's resources. Sometimes said that, "Planning without statistics is a ship without rudder and compass." For example- In India, a number of organizations like national sample survey organization(N.S.S.O.), central statistical organization (C.S.O.) are established to provide all types of information. 5. Importance in Business: The use of statistical methods in the solution of business problems dates almost exclusively to the 20th century. Or now days no business, large or small, public or private, can prosper without the help of statistics. Statistics provides necessary techniques to a businessman for the formulation of various policies and planning with regard to his business. Such as- (A) Marketing- In the field of marketing, it is necessary first to find out what can be sold and them to evolve a suitable strategy so that goods reach the ultimate consumer. A skillful analysis of data on population, purchasing power, habits of people, competition, transportation cost etc. should precede any attempt to establish a new market. (B) Quality Control- To earn the better price in a competitive market, it is necessary to watch the quality of the product. Statistical techniques can also be used to control the quality of the product manufactured by a firm. Such as - Showing the control chart. (C) Banking and Insurance Companies- banks use statistical techniques to take decisions regarding the average amount of cash needed each day to meet the requirements of day to day transactions. Various policies of investment and sanction of loans are also based on the analysis provided by statistics. (D) Accounts writing and Auditing- Every business firm keeps accounts of its revenue and expenditure. Statistical methods are also employed in accounting. In particular, the auditing function makes frequent application of statistical sampling and estimation procedures and the cost account uses regression analysis. (E) Research and Development- Many business organizations have their own research and development department which are responsible for collection of such data. These departments also prepare charts groups and other statistical analysis for the purpose.
FUNCTIONS OF STATISTICS
Statistics performs the functions of making the numerical aspects of facts simple, precise, comparable and reliable. In fact, the various functions performed by statistics are the basis of its

utility. R.W. Burgess says, "The fundamental gospel of statistics is to push back the domain of ignorance, prejudice, rule of thumb, arbitrary and premature decisions, tradition & dogmatism and to increase the domain in which decisions are made. Principles are formulated on the basis of analyzed quantitative facts."
1. Numerical and definite expression of facts: The first function of the statistics is the collection and

presentation of facts in numerical form. We know that the numerical presentation helps in having a better understanding of the nature of a problem. One of the most important functions of statistics is to present general statements in a precise and definite form. Statements and facts conveyed in exact quantitative terms are always more convincing than vague utterances. 2. Simplifies the data (condensation): Not only does statistics present facts in a definite form but it also helps in condensing mass of data into a few significant figures. According to A.E.Waugh, "the purpose of a statistical method is to simplify great bodies of numerical data."In fact, human mind cannot follow the huge, complex and scattered numerical facts. So these facts are made simple and precise with the help of various statistical methods like averages, dispersion, graphic or diagrammatic, presentation, classification, tabulation etc. so that a common man also understand them easily. 3. Comparison of facts: Baddington states, "The essence of the statistics is not only counting but also comparison." The function of comparison does help in showing the relative importance of data. For example- the pass % of examination result of a college may be appreciated better when it is compared with the result of other college or the results of previous years of the same college. 4. Establishment of relationship b/w two or more phenomena; to investigate the relationship b/w two or more facts is the main function of statistics. For example-demand and supply of a certain commodity, prices and wages, temperature and germination time of seeds are interrelated. 5. Enlarges individual experiences: In word of Bowley, "the proper function of statistics indeed is to enlarge individual experience." Statistics is like a master key that is used to solve problems of mankind in every field. It would not be exaggeration to say that many fields of knowledge would have remained closed to the mankind forever but for the efficient and useful techniques and methodology of the science of statistics. 6. Helps in the formulation of policies: statistics helps in formulating policies in different fields, especially in economic, social and political fields. The government policies like industrial policy, export-import policies, taxation policy and monetary policy are determined on the basis of statistical data and their movements, plan targets are also fixed with the help of data. 7. Helps in forecasting: statistical methods provide helpful means in estimating the available facts and forecasting for future. Here Bowley's statementis relevant that, "a statistical estimate may be good or bad, accurate or the reverse; but in almost all cases it is likely to be more accurate than a casual observer's impression."

8. Testing of hypothesis: statistical methods are also employed to test the hypothesis in theory and discover newer theory. For example-the statement that average height of students of college is 66 inches is a hypothesis. Here students of college constitute the population. It is possible to test the validity of this statement by the use of statistical techniques.

LIMITATIONS OF STATISTICS Newsholme states, "Statistics must be regarded as an instrument of research of great value but having several limitations which are not possible to overcome and as such they need out careful attention."
1. Statistics does not study qualitative facts: Statistics means aggregate of numerical facts. It means that in statistics only those phenomena are studied which can be expressed in numerical terms directly or indirectly. Such as- (1) directly in numerical terms like age, weight and income of individual (2) no directly but indirectly like intelligent of students and achievements of students (3) neither directly nor directly like morality, affection etc. such type of facts don't come under the scope of statistics. 2. Statistics doesn't study individual: According to W.I.King, "Statistics from their very nature of subject cannot and will never be able to take into account individual causes. When these are important, other means must be used for their study." These studied are done to compare the general behavior of the group at different points of time or the behavior of different

groups at a particular point of time. 3. Statistical results are true only on the average: The statistical laws are not completely true and accurate like the law of physics. For example – law of gravitational forces is perfectly true & universal but statistical conclusions are not perfectly true. Such as the average age of a person in India is 62 years. It does not mean that every person will attain this age. On the basis of statistical methods we can say only in terms of probability and not certainty. 4. Statistics as lack of complete accuracy: According to Conner, "Statistical data must always be treated as approximations or estimates and not as precise measurements." Statistical result are based on sample or census data, are bound to be true only approximately. For example – according to population census 2001, country's population is 1,02,70,15,247 but can real population may not be more or less by hundred, two hundred and so on. 5. Statistics is liable to be misused: Statistical deals with figures and it can be easily manipulated, distorted by the inexpert and unskilled persons it is very much likely to be misused in most of the cases. In other words, the data should be handled by experts. Thus it must be used by technically sound persons.

6. Statistics is only one of the methods of studying a phenomenon; According to Croxton & Cowden, "It must not be assumed that the statistical method is the only method to be used in research; neither this method be considered the best attack for every problem." The conclusions arrived at with the help of statistics must be supplemented with other evidences. 7. Statistical results may be misleading; Without any reference, statistical results may provide doubtful conclusions. For example – on the basis of increasing no. of prisoners in the prison, it may be conclude that crime is increasing. But it may be possible that due to rude behavior of police administration the number of prisoners is increasing but crime is decreasing.

Therefore, it is worth-mentioning that every science based on certain assumption and limitations. This does not reduce the importance of the subject but lays emphasis on the fact that precautions should be taken while dealing with statistical analysis and interpretations.

DISTRUST OF STATISTICS

For practical view point statistics is very useful and important science. We know that utility of statistics lies not merely in data but in correct analysis and proper interpretation of data. Several times due to ignorance and bias, people misuse this delicate tool of knowledge and it creates distrust about data.

Opinion about distrust of statistics; 1stOpinion–Statisticians fully trust on the statistical conclusions because data is collected, edited, analyzed and interpreted on the basis of statistical methods. Thus there is no reason to doubt on it and said that "Figures don't lie" or "Figures can prove nothing." 2nd Opinion –The statistics is looked upon with a suspicious eye and is quite often condemned as "Figures are tissue of flesh hood. Discardi remarks that there are three kinds of lies-lies, damned lies and statistics or "There are black lies, white lies, multi-chromatic lies and statistics is rainbow of lies."

Many persons feel that data are false, confusing and incorrect and with their help truth can be proved wrong and lies can be put as truth. Hence it is said that "Statistics can prove anything" or "Statistics are like clay of which you can make God or Devil, as you please." In this context, the observation is worth quoting that "Statistician is the person who is deeply involved in statistical data. He can freely play with them, misuse them and can cheat common people. So he is just magician who shows the games of tricks of hand through statistical data. His result can be surprising but not trustworthy.

Frequency in Quantitative Methods

Meaning:

- **Frequency** refers to the **number of times a particular observation or value occurs** in a dataset.
- It is a **basic concept in statistics** used to organize and summarize data.
- Helps in constructing **frequency distributions** for better understanding of data patterns.

Types of Frequency:

1. **Absolute Frequency (f):**
   - The **actual number of times** a value occurs.
   - Example: If 5 students scored 80 marks, the absolute frequency = 5.
2. **Relative Frequency (RF):**
   - Shows the **proportion or percentage** of total observations.
   - Formula:

$$\text{Relative Frequency} = \frac{\text{Absolute Frequency}}{\text{Total Observations}} \times 100$$

3. **Cumulative Frequency (CF):**
   - The **running total** of frequencies up to a certain value or class.
   - Used to determine **percentiles, quartiles, and median**.
   - Formula:

$$CF_i = f_1 + f_2 + \cdots + f_i$$

Frequency Distribution:

- A **tabular arrangement** of data showing **values or class intervals and their frequencies**.
- Helps **summarize large datasets** and visualize **data patterns**.

Example Table (Ungrouped Data):

Marks	Frequency (f)	Relative Frequency (%)	Cumulative Frequency (CF)
50	3	15	3
60	5	25	8
70	7	35	15
80	5	25	20
Total	20	100	-

Uses of Frequency:

- To **summarize and organize raw data**.
- Basis for **graphs, histograms, and frequency polygons**.
- Helps in **calculating mean, median, mode, and other statistical measures**.
- Useful in **business, finance, and research** for analyzing patterns and trends.

Merits:

- Simplifies **large datasets**.
- Facilitates **visualization of data**.

- Useful for **quick analysis** and comparison.

Limitations:

- Does not provide **exact values** of data in grouped frequency.
- May hide **individual variations** in large intervals.
- Requires **careful selection of class intervals** to avoid misleading results.

Conclusion:

Frequency is a **fundamental concept** in quantitative methods that allows organizing data for **analysis and interpretation**.

It is the foundation for constructing **frequency distributions, graphs, and statistical measures** used in MBA-level research and decisio

Frequency Distribution in Quantitative Methods

Meaning:

- **Frequency Distribution** is a **tabular or graphical representation** of data showing **values (or class intervals) and their corresponding frequencies**.
- It helps in **organizing raw data** to understand patterns, trends, and variations.
- Widely used in **business, finance, marketing, and research analysis**.

Definition:

A frequency distribution is a method of **summarizing a large set of data** by showing how frequently each value or group of values occurs.

Types of Frequency Distribution:

1. **Ungrouped Frequency Distribution:**
   - Data are listed **individually** with their frequencies.
   - Suitable for **small datasets**.
   - Example:

Value	Frequency
10	2
15	3
20	5

2. **Grouped Frequency Distribution:**
   - Data are arranged in **class intervals**.
   - Suitable for **large datasets**.
   - Example:

Class Interval	Frequency
0 – 10	4
10 – 20	8
20 – 30	6

Components of Frequency Distribution:

1. **Class Intervals:** Range of data values grouped together.
2. **Frequency (f):** Number of observations in each class.
3. **Relative Frequency (RF):** Proportion of total frequency.

4. **Cumulative Frequency (CF):** Running total of frequencies.
5. Optional: **Percentage frequency, midpoints, or boundaries**.

Steps to Construct a Frequency Distribution:

1. Determine **range of data**:

$$\text{Range} = \text{Max value} - \text{Min value}$$

2. Decide **number of classes** (usually 5–20 for large data).
3. Calculate **class width**:

$$\text{Class Width} = \frac{\text{Range}}{\text{Number of Classes}}$$

4. Set **class limits** and boundaries.
5. Count **frequency** of each class.
6. Calculate **relative and cumulative frequencies** (optional).

Graphical Representation:

- **Histogram:** Bar graph representing class intervals and frequencies.
- **Frequency Polygon:** Line graph joining midpoints of classes.
- **Ogive:** Cumulative frequency curve (less than/greater than).

Uses of Frequency Distribution:

- Simplifies **large datasets** for analysis.
- Basis for **calculating mean, median, mode, and other statistical measures**.
- Helps in **visualizing data trends and patterns**.
- Useful in **business analysis, market research, and quality control**.

Merits:

- Easy to **interpret and understand**.
- Provides **quick summary of data**.
- Helps in **comparisons and decision-making**.

Limitations:

- May **hide exact individual data points**.
- Choice of **class intervals** can affect interpretation.
- Requires careful **organization** to avoid misleading results.

Conclusion:

Frequency distribution is a **foundational tool in quantitative methods** that converts **raw data into meaningful information**, enabling analysis, visualization, and interpretation for **MBA-level decision-making**.

MEASURES OF CENTRAL TENDENCY

OBJECTIVES
After going through this unit, you will learn: • the concept and significance of measures of central tendency • to compute various measures of central tendency, such as arithmetic mean, median, mode and quartiles • the relationship among various averages.

INTRODUCTION

The objective here is to find one representative value which can-be used to locate and summarise the entire set of varying values. This one value can be used to make many decisions concerning the entire set. We can define measures of central tendency (or location) to find some central value around which the data tend to cluster.

SIGNIFICANCE OF MEASURES OF CENTRAI TENDENCY

Measures of central tendency i.e. condensing the mass of data in one single value , enable us to get an idea of the entire data. For example, it is impossible to remember the individual incomes of millions of earning people of India. But if the average income is obtained, we get one single value that represents the entire population. Measures of central tendency also enable us to compare two or more sets of data to facilitate comparison. For example, the average sales figures of April may be compared with the sales figures of previous months. PROPERTIES OF A GOOD MEASURE OF CENTRAL TENDENCY

[1] It should be easy to understand and calculate. [2] It should be rigidly defined. [3] It should be based on all observations. [4] It should be least affected by sampling fluctuation. [5] It should be capable of further algebraic treatment. [6] It should be least affected by extreme values. [7] It should be calculated in case of open end interval. Following are some of the important measures of central tendency which are commonly used in business and industry. 🎬 Arithmetic Mean 🎬 Weighted Arithmetic Mean 🎬 Median 🎬 Quantiles(quartiles, deciles and percentiles) 🎬 Mode 🎬 Geometric Mean 🎬 Harmonic Mean

ARITHMETIC MEAN

Arithmetic Mean in Quantitative Methods
Meaning:

- **Arithmetic Mean (AM)** is the **sum of all observations divided by the total number of**

observations.

- It is the **most commonly used measure of central tendency**.
- Represents the **average value** of a dataset.

Definition:
Arithmetic Mean is the **value obtained by dividing the sum of all observations by the number of observations**.

Formulas:

1. **For Ungrouped Data:**

$$\bar{X} = \frac{\sum X_i}{n}$$

2. **For Grouped Data:**

$$\bar{X} = \frac{\sum f_i X_i}{\sum f_i}$$

Where:

- X_i= individual observation
- f_i= frequency of observation
- n= total number of observations

Short-cut / Assumed Mean Method (for large data):

$$\bar{X} = A + \frac{\sum f_i d_i}{\sum f_i}$$

Where:

- A= assumed mean
- $d_i = X_i - A$(deviation from assumed mean)

Properties of Arithmetic Mean:

1. **Uniqueness:** Only one mean exists for a dataset.
2. **Uses all observations:** Each value affects the mean.
3. **Algebraic properties:**
   - $\sum(X_i - \bar{X}) = 0$
   - $\sum X_i = n\bar{X}$
4. **Affected by extreme values (outliers).**
5. **Expressed in same units** as data.

Merits of Arithmetic Mean:

- Simple and easy to calculate (especially with formula).
- Most widely used **average** in business, finance, and research.
- Basis for **further statistical calculations** (variance, SD, skewness).
- Uses all observations → more representative than median or mode.

Limitations:

- **Affected by extreme values** (not robust).
- Cannot be used for **qualitative data**.
- Sometimes **less meaningful** for open-ended classes or highly skewed data.

Uses:

- To measure **average performance, cost, or income**.
- Useful in **financial analysis, sales forecasting, and operational research**.
- Helps in **comparison of datasets** and decision-making.

Conclusion:

Arithmetic Mean is a **simple, widely used, and powerful measure of central tendency**.
It provides a **single representative value** for a dataset, serving as the foundation for **many MBA-level quantitative analyses**.

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MEDIAN

Median in Quantitative Methods

Meaning:

- **Median** is the **middle value** of a dataset when the data are arranged in **ascending or descending order**.
- It divides the data into **two equal halves**, with **50% of observations below** and **50% above**.
- Less affected by **extreme values** compared to arithmetic mean.

Definition:

Median is the **value which divides the dataset into two equal parts**, such that half the observations are below and half are above it.

Formulas:

1. **For Ungrouped Data:**

- **Odd number of observations:**

$$\text{Median} = \text{Middle value of arranged data}$$

- **Even number of observations:**

$$\text{Median} = \frac{\text{n/2 - th value} \; + \; \text{(n/2} \; + 1) \text{ - th value}}{2}$$

2. **For Grouped Data (Continuous Classes):**

$$\text{Median} = L + \frac{\frac{N}{2} - CF}{f} \times h$$

Where:

- L= lower boundary of median class
- N= total number of observations
- CF= cumulative frequency before median class
- f= frequency of median class
- h= class width

Properties of Median:

1. Divides data into **two equal halves**.
2. **Not affected by extreme values** (robust measure).
3. Can be determined **even when mean is not meaningful**.

4. Always **unique** for a dataset.

Merits:
- Simple and easy to calculate.
- Not affected by **outliers** or extreme values.
- Suitable for **ordinal and open-ended data**.
- Represents **central tendency effectively** in skewed distributions.

Limitations:
- Does **not consider all observations** (only position matters).
- Not suitable for **further algebraic/statistical calculations** (unlike mean).
- Less sensitive to small changes in data compared to mean.

Uses:
- To measure **central value** in **skewed distributions**.
- Useful in **income, wages, and sales data** with extreme values.
- Basis for calculating **quartiles, percentiles, and skewness**.

Conclusion:
Median is a **robust measure of central tendency** that divides data into two halves.
It is particularly useful in **skewed data** or when **extreme values** distort the mean, making it a preferred measure in **MBA quantitative analysis**.

MODE

Mode in Quantitative Methods
Meaning:
- **Mode** is the **value that occurs most frequently** in a dataset.
- Represents the **highest peak** in the frequency distribution.
- It is a **measure of central tendency** but focuses on **frequency** rather than arithmetic calculation.

Definition:
Mode is the **observation that has the maximum frequency** in a dataset.

Types of Mode:
1. **Unimodal:** One value occurs most frequently.
2. **Bimodal:** Two values occur most frequently.
3. **Multimodal:** More than two values occur most frequently.

Formulas:
1. **For Ungrouped Data:**

$$\text{Mode} = \text{Value with highest frequency}$$

2. **For Grouped Data (Continuous Classes) – Using Formula:**

$$\text{Mode} = L + \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \times h$$

Where:
- L= lower boundary of modal class

- f_1= frequency of modal class
- f_0= frequency of class before modal class
- f_2= frequency of class after modal class
- h= class width

Steps to Determine Mode (Grouped Data):

1. Identify the **modal class** (class with highest frequency).
2. Note **frequencies of neighboring classes**.
3. Apply the **mode formula** to calculate exact value.

Properties of Mode:

1. Always corresponds to the **highest frequency** in the data.
2. Can be **more than one value** (bimodal, multimodal).
3. **Not affected by extreme values** in the dataset.
4. Easy to determine for **qualitative and quantitative data**.

Merits:

- Simple and easy to understand.
- Can be used for **nominal, ordinal, interval, and ratio data**.
- **Unaffected by outliers**.
- Quick method to find **most popular or frequent item** in business data.

Limitations:

- Not always **unique** (can be bimodal or multimodal).
- Not suitable for **further statistical calculations** like variance or standard deviation.
- Less representative if **data frequencies are evenly spread**.

Uses:

- To identify **most common value** in datasets like sales, production, or customer preferences.
- Useful in **market research and quality control**.
- Serves as a **basis for calculating skewness** using Karl Pearson's formula:

$$\text{Mode} = 3 \times \text{Median} - 2 \times \text{Mean}$$

Conclusion:

Mode is a **simple, practical, and robust measure of central tendency**, especially useful for **qualitative data and datasets with repeating values**.
It complements **mean and median** in understanding the central value and distribution shape in **MBA-level quantitative analysis**.

Relationship Among Mean, Median, and Mode

Meaning:

- **Mean, median, and mode** are the three **measures of central tendency**.
- They summarize a dataset by giving a **typical or central value**.
- Their relationship is important to **understand skewness** in a distribution.

Empirical Relationship (Karl Pearson):

Karl Pearson proposed an **empirical formula** to relate mean, median, and mode:

$$\text{Mode} = 3 \times \text{Median} - 2 \times \text{Mean}$$

Or equivalently:

$$\text{Mean} - \text{Mode} = 3 \times (\text{Mean} - \text{Median})$$

Interpretation:

Type of Distribution	Relationship	Observation
Symmetrical (Normal)	Mean = Median = Mode	No skewness
Positively Skewed	Mean > Median > Mode	Tail extends to the right
Negatively Skewed	Mean < Median < Mode	Tail extends to the left

Graphical Representation:

1. **Symmetrical Distribution:**
- Bell-shaped curve, peak at center
- Mean = Median = Mode
2. **Positive Skew:**
- Peak shifts to the left
- Mean pulled to the right
3. **Negative Skew:**
- Peak shifts to the right
- Mean pulled to the left

Uses:

- To **estimate the mode** if not given.
- To **determine skewness** of the distribution.
- Helps in **statistical and business analysis**, e.g., income distribution, exam scores.

Conclusion:

The relationship among mean, median, and mode helps **understand the shape and skewness** of a distribution.
Karl Pearson's empirical formula is widely used in **quantitative analysis** for **approximating the mode** and analyzing skewness.

Range in Quantitative Methods
Meaning:

- **Range** is the simplest **measure of dispersion** (variation or spread) in a data set.
- It shows the **difference between the highest (maximum)** and **lowest (minimum)** values of a variable.
- It tells how widely the data values are spread.

Formula:

$$\text{Range (R)} = \text{Highest Value} - \text{Lowest Value}$$

Example:
If marks obtained by students are 25, 40, 60, 80, and 90
→ Range = 90 – 25 = **65**

Coefficient of Range:
To compare the spread between two or more data sets, we use a **relative measure** called the **Coefficient of Range**.

$$\text{Coefficient of Range} = \frac{\text{Highest Value} - \text{Lowest Value}}{\text{Highest Value} + \text{Lowest Value}}$$

Example:
If maximum = 90, minimum = 25
→ Coefficient of Range = (90 – 25) / (90 + 25) = 65 / 115 = **0.565**

Uses of Range:

- To quickly estimate the **variability** in data.
- Useful in **quality control**, **stock market analysis**, and **business forecasting**.
- Helpful in **decision-making** where rapid comparison of variability is needed.

Merits:

- **Simple and easy** to calculate.
- Gives a **quick idea** about data spread.
- Useful for **small data sets** or **preliminary analysis**.

Limitations:

- Depends only on **two extreme values** — may ignore the rest of the data.
- **Not reliable** for data with **outliers** or wide fluctuations.
- **Cannot be used** for detailed statistical analysis.

Conclusion:
Range is a **basic measure of dispersion** used to show how far apart data values are.
Though simple, it should be supported by other measures like **mean deviation**, **standard deviation**, or **quartile deviation** for deeper analysis.

Would you like me to include a **short numerical example with grouped data (class intervals)** as well? That's often asked in MBA quantitative methods exams.

Kurtosis in Quantitative Methods
Meaning:

- **Kurtosis** is a **statistical measure** that describes the **shape of a frequency distribution curve**, especially the **peakedness** or **flatness** of the data compared to a normal distribution.
- It shows how the data values are concentrated around the mean.

Definition:
Kurtosis measures the **degree of sharpness or flatness** in the frequency curve of a distribution compared with the normal curve.

Types of Kurtosis:
There are **three main types**:

1. **Leptokurtic ($\beta_2 > 3$):**
   - Curve is **more peaked** than the normal distribution.
   - Most data are **concentrated near the mean**.
   - Indicates **low variability** and **heavy tails**.
   - Example: Exam scores where most students score near average.
2. **Mesokurtic ($\beta_2 = 3$):**
   - Curve is **normally shaped** (standard normal distribution).
   - **Moderate** peak and tails.
   - Acts as a **reference** for comparison.
3. **Platykurtic ($\beta_2 < 3$):**
   - Curve is **flatter** than normal distribution.
   - Data are **more spread out** around the mean.
   - Indicates **high variability** and **light tails**.
   - Example: Income distribution in a very diverse population.

Formula:
For a dataset:

$$\beta_2 = \frac{M_4}{(M_2)^2}$$

Where:

- M_2= Second central moment (variance)
- M_4= Fourth central moment

And,

$$\text{Excess Kurtosis} = \beta_2 - 3$$

- If **> 0** → Leptokurtic
- If **= 0** → Mesokurtic
- If **< 0** → Platykurtic

Graphical Representation:

Type	Shape of Curve	β_2 Value	Description
Leptokurtic	Very peaked	> 3	Data near mean
Mesokurtic	Normal peak	= 3	Normal curve
Platykurtic	Flat curve	< 3	Data spread out

Uses of Kurtosis:

- To understand **data concentration** around the mean.
- Helps in **financial risk analysis** — higher kurtosis means higher chance of extreme outcomes.

- Useful in **quality control** and **process variation analysis**.

Merits:
- Provides **insight into data distribution shape**.
- Helps detect **outliers** and **risk levels** in datasets.
- Supports **decision-making** in finance, marketing, and operations.

Limitations:
- Does not show **data direction** (unlike skewness).
- May be **sensitive to outliers**.
- Difficult to interpret without comparing to a normal distribution.

Conclusion:
Kurtosis helps to **analyze the shape** of data distribution beyond mean and variance.
It complements **skewness**, giving a **complete picture** of how data values are distributed around the mean.

Skewness in Quantitative Methods
Meaning:
- **Skewness** is a **measure of asymmetry** of a data distribution around its mean.
- In a **perfectly symmetrical distribution**, the **mean = median = mode**.
- When data are **not symmetrical**, the distribution is said to be **skewed**.

Definition:
Skewness indicates the **degree and direction** of deviation from the normal (symmetrical) distribution.

Types of Skewness:
1. **Positive (Right) Skewness:**
   - Tail of the curve extends **toward the right**.
   - Most data values lie **on the left side** of the mean.
   - **Mean > Median > Mode**
   - Example: Income distribution (few people earn very high incomes).
2. **Negative (Left) Skewness:**
   - Tail of the curve extends **toward the left**.
   - Most data values lie **on the right side** of the mean.
   - **Mean < Median < Mode**
   - Example: Age at retirement (most people retire around 60, few earlier).
3. **Zero Skewness (Symmetrical Distribution):**
   - No skewness; curve is **symmetrical**.
   - **Mean = Median = Mode**
   - Example: Ideal normal distribution.

Graphical Representation:

Type	Shape	Relationship among Mean, Median, Mode
Positive Skew	Tail to right	Mean > Median > Mode
Negative Skew	Tail to left	Mean < Median < Mode
Zero Skew	Symmetrical	Mean = Median = Mode

Measures of Skewness:

1. **Karl Pearson's Coefficient of Skewness**

$$\text{Sk} = \frac{\text{Mean} - \text{Mode}}{\text{Standard Deviation}}$$

Or, if mode is not available:

$$\text{Sk} = \frac{3(\text{Mean} - \text{Median})}{\text{Standard Deviation}}$$

   - **Sk > 0** → Positively skewed
   - **Sk < 0** → Negatively skewed
   - **Sk = 0** → Symmetrical

2. **Bowley's Coefficient of Skewness (Based on Quartiles)**

$$\text{Sk} = \frac{(Q_3 + Q_1 - 2 \times \text{Median})}{(Q_3 - Q_1)}$$

   - Used when data are open-ended or when mode/mean are not defined.

3. **Kelly's Coefficient of Skewness (Based on Percentiles)**

$$\text{Sk} = \frac{(P_{90} + P_{10} - 2 \times P_{50})}{(P_{90} - P_{10})}$$

Uses of Skewness:

- To know whether data are **symmetrical or not**.
- Helps in understanding **data trend and direction**.
- Useful in **financial analysis**, **quality control**, and **market research**.
- Aids in **choosing correct statistical tools** (since many tests assume normal distribution).

Merits:

- Simple to calculate and interpret.
- Helps in detecting **data bias** or **outliers**.
- Indicates **direction of variation** in data.

Limitations:

- Does not show **degree of peakedness** (that's measured by kurtosis).
- Sensitive to **extreme values**.
- May not reflect full data pattern for complex distributions.

Conclusion:

Skewness helps identify **asymmetry in data** and shows whether observations are concentrated on one side of the mean.
It's an important part of **descriptive statistics** and provides insight into the **nature and direction** of data distribution.

Karl Pearson's Coefficient of Skewness

Meaning:

- **Karl Pearson's coefficient of skewness** is a **quantitative measure of asymmetry** in a frequency distribution.
- It shows **how far and in which direction** the distribution deviates from a symmetrical (normal) curve.
- It was developed by **Karl Pearson**, a British statistician.

Definition:
Karl Pearson's coefficient of skewness measures the **degree and direction of skewness** based on the relationship between **mean, median, and mode**.

Formula:

1. **When Mode is Known:**

$$Sk = \frac{\text{Mean} - \text{Mode}}{\text{Standard Deviation}}$$

2. **When Mode is Not Known:**
   - Use the empirical relationship:

$$\text{Mode} = 3 \times \text{Median} - 2 \times \text{Mean}$$

   - Substitute in the formula:

$$Sk = \frac{3(\text{Mean} - \text{Median})}{\text{Standard Deviation}}$$

Interpretation:

Value of Sk	Type of Distribution	Nature of Curve
Sk = 0	Symmetrical	Normal curve
Sk > 0	Positively skewed	Tail toward right
Sk < 0	Negatively skewed	Tail toward left

Example:

Measure	Value
Mean	60
Median	55
SD	10

Then,

$$Sk = \frac{3(60 - 55)}{10} = \frac{15}{10} = 1.5$$

→ The distribution is **positively skewed**.

Uses:

- To measure the **degree and direction of skewness** in data.
- Helps compare **two or more datasets** for asymmetry.
- Commonly used in **business, finance, and quality control** to understand data pattern.
- Useful in checking **normality** before applying statistical tests.

Merits:

- **Simple and easy** to calculate.
- Gives a **clear numerical value** of skewness.
- Based on **well-known parameters** — mean, median, and standard deviation.

Limitations:

- **Sensitive to extreme values** (outliers).
- Not suitable when **mean or mode** are not well defined.

- Only measures **one aspect** of distribution (asymmetry), not peakedness (kurtosis).

Conclusion:
Karl Pearson's coefficient of skewness is a **simple and widely used method** to measure asymmetry in a dataset.
It helps determine whether data are **positively skewed**, **negatively skewed**, or **symmetrical**, thus giving deeper insight into **data distribution characteristics**.

Bowley's Coefficient of Skewness
Meaning:

- **Bowley's coefficient of skewness** is a **measure of asymmetry** based on **quartiles** (Q_1, Q_2, Q_3).
- It was introduced by **Arthur Lyon Bowley**.
- It measures **skewness in the middle 50% of data**, ignoring extreme values (outliers).
- Hence, it is also known as a **quartile measure of skewness**.

Definition:
Bowley's coefficient of skewness measures the **degree and direction of skewness** in a distribution using **quartiles and median**.

Formula:

$$\text{Sk}_B = \frac{(Q_3 + Q_1 - 2 \times \text{Median})}{(Q_3 - Q_1)}$$

Where:

- Q_1= First Quartile (25th percentile)
- Q_2= Median (50th percentile)
- Q_3= Third Quartile (75th percentile)

Interpretation:

Value of Sk_B	Type of Distribution	Nature of Curve
Sk_B = 0	Symmetrical	Normal curve
Sk_B > 0	Positively skewed	Tail toward right
Sk_B < 0	Negatively skewed	Tail toward left

Range of Values:

$$-1 \leq \text{Sk}_B \leq +1$$

Example:
If
$Q_1 = 40, Q_2 = 50, Q_3 = 70$
Then

$$\text{Sk}_B = \frac{(70 + 40 - 2(50))}{(70 - 40)} = \frac{110 - 100}{30} = \frac{10}{30} = 0.33$$

→ The distribution is **positively skewed**.

Uses:

- Useful when **extreme values are present**, since it focuses on the central part of the data.
- Helps to study **income, wages, and consumption** data, which often have outliers.
- Suitable for **open-ended frequency distributions** where mean or mode cannot be determined.

Merits:
- **Simple and easy** to calculate.
- **Less affected by extreme values** than Karl Pearson's coefficient.
- Can be used even when **mean or mode are undefined**.

Limitations:
- Uses only **three values (Q_1, Q_2, Q_3)** — ignores rest of the data.
- Less accurate for **small data sets**.
- Not suitable when data are **highly irregular** or unevenly distributed.

Conclusion:
Bowley's coefficient of skewness provides a **robust and simple method** to measure asymmetry using quartiles.
It is especially useful when data contain **extreme values** or **open-end classes**, giving a reliable indication of the **direction and degree of skewness**.

Standard Deviation (SD) in Quantitative Methods
Meaning:
- **Standard Deviation** is a **measure of dispersion** that shows how much individual observations **deviate from the mean** of a dataset.
- It is considered the **most reliable measure of variability** because it takes **all observations** into account.
- Smaller SD → data clustered around mean,
  Larger SD → data widely spread from mean.

Definition:
Standard deviation measures the **average distance of each data point from the mean** in a dataset.

Symbol:
- Population SD → σ
- Sample SD → s

Formulas:
1. **For Population:**

$$\sigma = \sqrt{\frac{\sum(X_i - \mu)^2}{N}}$$

2. **For Sample:**

$$s = \sqrt{\frac{\sum(X_i - \bar{X})^2}{n-1}}$$

Where:

- X_i= individual observation
- μ= population mean
- $\bar{X}$= sample mean
- N= population size
- n= sample size

Shortcut Formula (Computational Formula):

$$\sigma = \sqrt{\frac{\sum X_i^2}{N} - (\frac{\sum X_i}{N})^2}$$

Coefficient of Variation (CV):

- To compare variability of two datasets with **different means**, we use **CV**:

$$CV = \frac{\text{SD}}{\text{Mean}} \times 100$$

- Lower CV → less relative variability
- Higher CV → more relative variability

Properties of Standard Deviation:

1. Always **non-negative** ($\sigma \geq 0$).
2. **Zero SD** → all observations are identical.
3. Sensitive to **every data value**, especially **outliers**.
4. Expressed in the **same unit** as the data.
5. SD increases as **spread increases**.

Uses:

- To measure **risk in finance** (e.g., stock price fluctuations).
- To assess **consistency in business performance**.
- Useful in **quality control** and **decision-making**.
- Helps in **comparing variability** between datasets.

Merits:

- Uses **all data points** → more accurate.
- Compatible with **further statistical calculations**.
- Standard measure in **business, finance, and research**.

Limitations:

- Sensitive to **extreme values** (outliers).
- Slightly **complex to calculate** for large datasets.
- Not always suitable for **ordinal or open-ended data**.

Conclusion:

Standard deviation is a **powerful measure of dispersion** that indicates how data points are distributed around the mean.
It is widely used in **MBA quantitative methods**, finance, operations, and business research for **analyzing variability and risk**.

Mean Deviation (MD) in Quantitative Methods

Meaning:

- **Mean Deviation** is a **measure of dispersion** that indicates the **average deviation of all observations from a central value** (mean, median, or mode).
- It shows how **spread out** the data is around a central value.
- Less affected by large fluctuations than variance but less precise than standard deviation.

Definition:

Mean deviation is the **average of the absolute differences** between each data point and a central tendency measure (mean, median, or mode).

Formula:

1. **About the Mean ($\bar{X}$):**

$$MD = \frac{\sum | X_i - \bar{X} |}{n}$$

2. **About the Median (M):**

$$MD = \frac{\sum | X_i - M |}{n}$$

3. **About the Mode (Mo):**

$$MD = \frac{\sum | X_i - Mo |}{n}$$

Where:

- X_i= individual observation
- n= number of observations
- $\bar{X}$= mean
- M= median
- Mo= mode

Properties of Mean Deviation:

1. Always **non-negative** ($MD \geq 0$).
2. **Zero MD** → all observations are equal.
3. Less affected by extreme values than **standard deviation**.
4. Expressed in the **same unit** as the data.

Uses:

- To measure **average spread** of data around a central value.
- Useful in **business, finance, and economics** for analyzing variability.
- Helps in **comparing datasets** for consistency.

Merits:

- Simple to calculate and easy to understand.
- Can be based on **mean, median, or mode**.
- Less sensitive to **outliers** compared to standard deviation.

Limitations:

- Not suitable for **further statistical analysis** (unlike SD).
- Ignores the **direction of deviation** (all deviations treated as positive).

- Less precise than **variance or standard deviation**.

Conclusion:
Mean deviation is a **simple and useful measure of dispersion** to understand **average variation** in data.
It is particularly helpful when **simplicity and quick assessment** of variability are more important than mathematical precision.

Quartile Deviation (QD) in Quantitative Methods
Meaning:

- **Quartile Deviation (QD)** is a **measure of dispersion** that shows the **spread of the middle 50% of the data**.
- It is based on **quartiles** (Q_1 and Q_3).
- Less affected by **extreme values** compared to range and standard deviation.
- Also called **Semi-Interquartile Range (SIQR)**.

Definition:
Quartile Deviation is **half the difference between the third quartile (Q_3) and the first quartile (Q_1)**.
It represents the **average spread of the middle 50% of observations**.

Formula:

$$QD = \frac{Q_3 - Q_1}{2}$$

- **Q_1** = First Quartile (25th percentile)
- **Q_3** = Third Quartile (75th percentile)

Coefficient of Quartile Deviation (for comparison between datasets):

$$CQD = \frac{Q_3 - Q_1}{Q_3 + Q_1}$$

Steps to Calculate QD (Grouped Data):

1. Determine **N** = total number of observations.
2. Find **Q_1** (25th percentile) and **Q_3** (75th percentile) using the formula:
   - $Q_1 = L + \frac{(N/4 - CF)}{f} \times h$
   - $Q_3 = L + \frac{(3N/4 - CF)}{f} \times h$

     Where:
     - L = lower boundary of quartile class
     - CF = cumulative frequency before quartile class
     - f = frequency of quartile class
     - h = class width
3. Substitute **Q_1** and **Q_3** in $QD = (Q_3 - Q_1)/2$

Properties:

1. **Always non-negative** ($QD \geq 0$)
2. **Resistant to extreme values** (robust measure)
3. Measures **spread of middle 50% of data**

4. Expressed in the **same unit** as the data

Uses:

- To study **spread and consistency** of central data.
- Useful for **income, wages, or exam scores**, where extremes exist.
- Can compare **dispersion between two datasets** using Coefficient of QD.

Merits:

- **Easy to calculate** for both ungrouped and grouped data.
- **Less affected by outliers** compared to range and SD.
- Gives a **robust measure of central dispersion**.

Limitations:

- Ignores **25% of data at each end**; not based on all observations.
- Less commonly used in **advanced statistical analysis**.
- Cannot be used directly for **further statistical computations** like variance.

Conclusion:

Quartile Deviation is a **simple and robust measure of dispersion** focused on the **middle 50% of the data**.
It is especially useful when data have **extreme values or outliers**, providing a clear idea of **central spread** without being distorted by extremes.