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Measurement and Scaling Techniques

MEASUREMENT IN RESEARCH

In our daily life we are said to measure when we use some yardstick to determine weight, height, or some other feature of a physical object. We also measure when we judge how well we like a song, a painting or the personalities of our friends. We, thus, measure physical objects as well as abstract concepts. Measurement is a relatively complex and demanding task, specially so when it concerns qualitative or abstract phenomena. By measurement we mean the process of assigning numbers to objects or observations, the level of measurement being a function of the rules under which the numbers are assigned.

It is easy to assign numbers in respect of properties of some objects, but it is relatively difficult in respect of others. For instance, measuring such things as social conformity, intelligence, or marital adjustment is much less obvious and requires much closer attention than measuring physical weight, biological age or a person's financial assets. In other words, properties like weight, height, etc., can be measured directly with some standard unit of measurement, but it is not that easy to measure properties like motivation to succeed, ability to stand stress and the like. We can expect high accuracy in measuring the length of pipe with a yard stick, but if the concept is abstract and the measurement tools are not standardized, we are less confident about the accuracy of the results of measurement.

Technically speaking, measurement is a process of mapping aspects of a domain onto other aspects of a range according to some rule of correspondence. In measuring, we devise some form of scale in the range (in terms of set theory, range may refer to some set) and then transform or map the properties of objects from the domain (in terms of set theory, domain may refer to some other set) onto this scale. For example, in case we are to find the male to female attendance ratio while conducting a study of persons who attend some show, then we may tabulate those who come to the show according to sex. In terms of set theory, this process is one of mapping the observed physical properties of those coming to the show (the domain) on to a sex classification (the range). The rule of correspondence is: If the object in the domain appears to be male, assign to "0" and if female assign to "1". Similarly, we can record a person's marital status as 1, 2, 3 or 4, depending on whether

the person is single, married, widowed or divorced. We can as well record "Yes or No" answers to a question as "0" and "1" (or as 1 and 2 or perhaps as 59 and 60). In this artificial or nominal way, categorical data (qualitative or descriptive) can be made into numerical data and if we thus code the various categories, we refer to the numbers we record as nominal data. *Nominal data* are numerical in name only, because they do not share any of the properties of the numbers we deal in ordinary arithmetic. For instance if we record marital status as 1, 2, 3, or 4 as stated above, we cannot write $4 > 2$ or $3 < 4$ and we cannot write $3 - 1 = 4 - 2$, $1 + 3 = 4$ or $4 \div 2 = 2$.

In those situations when we cannot do anything except set up inequalities, we refer to the data as *ordinal data.* For instance, if one mineral can scratch another, it receives a higher hardness number and on Mohs' scale the numbers from 1 to 10 are assigned respectively to talc, gypsum, calcite, fluorite, apatite, feldspar, quartz, topaz, sapphire and diamond. With these numbers we can write $5 > 2$ or $6 < 9$ as apatite is harder than gypsum and feldspar is softer than sapphire, but we cannot write for example $10 - 9 = 5 - 4$, because the difference in hardness between diamond and sapphire is actually much greater than that between apatite and fluorite. It would also be meaningless to say that topaz is twice as hard as fluorite simply because their respective hardness numbers on Mohs' scale are 8 and 4. The greater than symbol (i.e., >) in connection with ordinal data may be used to designate "happier than" "preferred to" and so on.

When in addition to setting up inequalities we can also form differences, we refer to the data as *interval data.* Suppose we are given the following temperature readings (in degrees Fahrenheit): 58°, 63°, 70°, 95°, 110°, 126° and 135°. In this case, we can write $100° > 70°$ or $95° < 135°$ which simply means that 110° is warmer than 70° and that 95° is cooler than 135°. We can also write for example $95° - 70° = 135° - 110°$, since equal temperature differences are equal in the sense that the same amount of heat is required to raise the temperature of an object from 70° to 95° or from 110° to 135°. On the other hand, it would not mean much if we said that 126° is twice as hot as 63°, even though $126° \div 63° = 2$. To show the reason, we have only to change to the centigrade scale, where the first temperature becomes $5/9\ (126 - 32) = 52°$, the second temperature becomes $5/9\ (63 - 32) = 17°$ and the first figure is now more than three times the second. This difficulty arises from the fact that Fahrenheit and Centigrade scales both have artificial origins (zeros) i.e., the number 0 of neither scale is indicative of the absence of whatever quantity we are trying to measure.

When in addition to setting up inequalities and forming differences we can also form quotients (i.e., when we can perform all the customary operations of mathematics), we refer to such data as *ratio data.* In this sense, ratio data includes all the usual measurement (or determinations) of length, height, money amounts, weight, volume, area, pressures etc.

The above stated distinction between nominal, ordinal, interval and ratio data is important for the nature of a set of data may suggest the use of particular statistical techniques*. A researcher has to be quite alert about this aspect while measuring properties of objects or of abstract concepts.

* When data can be measured in units which are interchangeable e.g., weights (by ratio scales), temperatures (by interval scales), that data is said to be parametric and can be subjected to most kinds of statistical and mathematical processes. But when data is measured in units which are not interchangeable, e.g., product preferences (by ordinal scales), the data is said to be non-parametric and is susceptible only to a limited extent to mathematical and statistical treatment.

MEASUREMENT SCALES

From what has been stated above, we can write that scales of measurement can be considered in terms of their mathematical properties. The most widely used classification of measurement scales are: (a) nominal scale; (b) ordinal scale; (c) interval scale; and (d) ratio scale.

(a) Nominal scale: Nominal scale is simply a system of assigning number symbols to events in order to label them. The usual example of this is the assignment of numbers of basketball players in order to identify them. Such numbers cannot be considered to be associated with an ordered scale for their order is of no consequence; the numbers are just convenient labels for the particular class of events and as such have no quantitative value. Nominal scales provide convenient ways of keeping track of people, objects and events. One cannot do much with the numbers involved. For example, one cannot usefully average the numbers on the back of a group of football players and come up with a meaningful value. Neither can one usefully compare the numbers assigned to one group with the numbers assigned to another. The counting of members in each group is the only possible arithmetic operation when a nominal scale is employed. Accordingly, we are restricted to use mode as the measure of central tendency. There is no generally used measure of dispersion for nominal scales. Chi-square test is the most common test of statistical significance that can be utilized, and for the measures of correlation, the contingency coefficient can be worked out.

Nominal scale is the least powerful level of measurement. It indicates no order or distance relationship and has no arithmetic origin. A nominal scale simply describes differences between things by assigning them to categories. Nominal data are, thus, counted data. The scale wastes any information that we may have about varying degrees of attitude, skills, understandings, etc. In spite of all this, nominal scales are still very useful and are widely used in surveys and other *ex-post-facto* research when data are being classified by major sub-groups of the population.

(b) Ordinal scale: The lowest level of the ordered scale that is commonly used is the ordinal scale. The ordinal scale places events in order, but there is no attempt to make the intervals of the scale equal in terms of some rule. Rank orders represent ordinal scales and are frequently used in research relating to qualitative phenomena. A student's rank in his graduation class involves the use of an ordinal scale. One has to be very careful in making statement about scores based on ordinal scales. For instance, if Ram's position in his class is 10 and Mohan's position is 40, it cannot be said that Ram's position is four times as good as that of Mohan. The statement would make no sense at all. Ordinal scales only permit the ranking of items from highest to lowest. Ordinal measures have no absolute values, and the real differences between adjacent ranks may not be equal. All that can be said is that one person is higher or lower on the scale than another, but more precise comparisons cannot be made.

Thus, the use of an ordinal scale implies a statement of 'greater than' or 'less than' (an equality statement is also acceptable) without our being able to state how much greater or less. The real difference between ranks 1 and 2 may be more or less than the difference between ranks 5 and 6. Since the numbers of this scale have only a rank meaning, the appropriate measure of central tendency is the median. A percentile or quartile measure is used for measuring dispersion. Correlations are restricted to various rank order methods. Measures of statistical significance are restricted to the non-parametric methods.

(c) Interval scale: In the case of interval scale, the intervals are adjusted in terms of some rule that has been established as a basis for making the units equal. The units are equal only in so far as one

accepts the assumptions on which the rule is based. Interval scales can have an arbitrary zero, but it is not possible to determine for them what may be called an absolute zero or the unique origin. The primary limitation of the interval scale is the lack of a true zero; it does not have the capacity to measure the complete absence of a trait or characteristic. The Fahrenheit scale is an example of an interval scale and shows similarities in what one can and cannot do with it. One can say that an increase in temperature from 30° to 40° involves the same increase in temperature as an increase from 60° to 70°, but one cannot say that the temperature of 60° is twice as warm as the temperature of 30° because both numbers are dependent on the fact that the zero on the scale is set arbitrarily at the temperature of the freezing point of water. The ratio of the two temperatures, 30° and 60°, means nothing because zero is an arbitrary point.

Interval scales provide more powerful measurement than ordinal scales for interval scale also incorporates the concept of equality of interval. As such more powerful statistical measures can be used with interval scales. Mean is the appropriate measure of central tendency, while standard deviation is the most widely used measure of dispersion. Product moment correlation techniques are appropriate and the generally used tests for statistical significance are the 't' test and 'F' test.

(d) Ratio scale: Ratio scales have an absolute or true zero of measurement. The term 'absolute zero' is not as precise as it was once believed to be. We can conceive of an absolute zero of length and similarly we can conceive of an absolute zero of time. For example, the zero point on a centimeter scale indicates the complete absence of length or height. But an absolute zero of temperature is theoretically unobtainable and it remains a concept existing only in the scientist's mind. The number of minor traffic-rule violations and the number of incorrect letters in a page of type script represent scores on ratio scales. Both these scales have absolute zeros and as such all minor traffic violations and all typing errors can be assumed to be equal in significance. With ratio scales involved one can make statements like "Jyoti's" typing performance was twice as good as that of "Reetu." The ratio involved does have significance and facilitates a kind of comparison which is not possible in case of an interval scale.

Ratio scale represents the actual amounts of variables. Measures of physical dimensions such as weight, height, distance, etc. are examples. Generally, all statistical techniques are usable with ratio scales and all manipulations that one can carry out with real numbers can also be carried out with ratio scale values. Multiplication and division can be used with this scale but not with other scales mentioned above. Geometric and harmonic means can be used as measures of central tendency and coefficients of variation may also be calculated.

Thus, proceeding from the nominal scale (the least precise type of scale) to ratio scale (the most precise), relevant information is obtained increasingly. If the nature of the variables permits, the researcher should use the scale that provides the most precise description. Researchers in physical sciences have the advantage to describe variables in ratio scale form but the behavioural sciences are generally limited to describe variables in interval scale form, a less precise type of measurement.

Sources of Error in Measurement

Measurement should be precise and unambiguous in an ideal research study. This objective, however, is often not met with in entirety. As such the researcher must be aware about the sources of error in measurement. The following are the possible sources of error in measurement.

(a) Respondent: At times the respondent may be reluctant to express strong negative feelings or it is just possible that he may have very little knowledge but may not admit his ignorance. All this reluctance is likely to result in an interview of 'guesses.' Transient factors like fatigue, boredom, anxiety, etc. may limit the ability of the respondent to respond accurately and fully.

(b) Situation: Situational factors may also come in the way of correct measurement. Any condition which places a strain on interview can have serious effects on the interviewer-respondent rapport. For instance, if someone else is present, he can distort responses by joining in or merely by being present. If the respondent feels that anonymity is not assured, he may be reluctant to express certain feelings.

(c) Measurer: The interviewer can distort responses by rewording or reordering questions. His behaviour, style and looks may encourage or discourage certain replies from respondents. Careless mechanical processing may distort the findings. Errors may also creep in because of incorrect coding, faulty tabulation and/or statistical calculations, particularly in the data-analysis stage.

(d) Instrument: Error may arise because of the defective measuring instrument. The use of complex words, beyond the comprehension of the respondent, ambiguous meanings, poor printing, inadequate space for replies, response choice omissions, etc. are a few things that make the measuring instrument defective and may result in measurement errors. Another type of instrument deficiency is the poor sampling of the universe of items of concern.

Researcher must know that correct measurement depends on successfully meeting all of the problems listed above. He must, to the extent possible, try to eliminate, neutralize or otherwise deal with all the possible sources of error so that the final results may not be contaminated.

Tests of Sound Measurement

Sound measurement must meet the tests of validity, reliability and practicality. In fact, these are the three major considerations one should use in evaluating a measurement tool. "Validity refers to the extent to which a test measures what we actually wish to measure. Reliability has to do with the accuracy and precision of a measurement procedure ... Practicality is concerned with a wide range of factors of economy, convenience, and interpretability ..."[1] We briefly take up the relevant details concerning these tests of sound measurement.

1. Test of Validity[*]

Validity is the most critical criterion and indicates the degree to which an instrument measures what it is supposed to measure. Validity can also be thought of as utility. In other words, validity is the extent to which differences found with a measuring instrument reflect true differences among those being tested. But the question arises: how can one determine validity without direct confirming knowledge? The answer may be that we seek other relevant evidence that confirms the answers we have found with our measuring tool. What is relevant, evidence often depends upon the nature of the

[1] Robert L. Thorndike and Elizabeth Hagen: *Measurement and Evaluation in Psychology and Education,* 3rd Ed., p. 162.

[*] Two forms of validity are usually mentioned in research literature viz., the external validity and the internal validity. External validity of research findings is their generalizability to populations, settings, treatment variables and measurement variables. We shall talk about it in the context of significance tests later on. The internal validity of a research design is its ability to measure what it aims to measure. We shall deal with this validity only in the present chapter.

research problem and the judgement of the researcher. But one can certainly consider three types of validity in this connection: (i) Content validity; (ii) Criterion-related validity and (iii) Construct validity.

(i) *Content validity* is the extent to which a measuring instrument provides adequate coverage of the topic under study. If the instrument contains a representative sample of the universe, the content validity is good. Its determination is primarily judgemental and intuitive. It can also be determined by using a panel of persons who shall judge how well the measuring instrument meets the standards, but there is no numerical way to express it.

(ii) *Criterion-related validity* relates to our ability to predict some outcome or estimate the existence of some current condition. This form of validity reflects the success of measures used for some empirical estimating purpose. The concerned criterion must possess the following qualities:

Relevance: (A criterion is relevant if it is defined in terms we judge to be the proper measure.)

Freedom from bias: (Freedom from bias is attained when the criterion gives each subject an equal opportunity to score well.)

Reliability: (A reliable criterion is stable or reproducible.)

Availability: (The information specified by the criterion must be available.)

In fact, a Criterion-related validity is a broad term that actually refers to (i) *Predictive validity* and *(ii) Concurrent validity.* The former refers to the usefulness of a test in predicting some future performance whereas the latter refers to the usefulness of a test in closely relating to other measures of known validity. Criterion-related validity is expressed as the coefficient of correlation between test scores and some measure of future performance or between test scores and scores on another measure of known validity.

(iii) *Construct validity* is the most complex and abstract. A measure is said to possess construct validity to the degree that it confirms to predicted correlations with other theoretical propositions. Construct validity is the degree to which scores on a test can be accounted for by the explanatory constructs of a sound theory. For determining construct validity, we associate a set of other propositions with the results received from using our measurement instrument. If measurements on our devised scale correlate in a predicted way with these other propositions, we can conclude that there is some construct validity.

If the above stated criteria and tests are met with, we may state that our measuring instrument is valid and will result in correct measurement; otherwise we shall have to look for more information and/or resort to exercise of judgement.

2. Test of Reliability

The test of reliability is another important test of sound measurement. A measuring instrument is reliable if it provides consistent results. Reliable measuring instrument does contribute to validity, but a reliable instrument need not be a valid instrument. For instance, a scale that consistently overweighs objects by five kgs., is a reliable scale, but it does not give a valid measure of weight. But the other way is not true i.e., a valid instrument is always reliable. Accordingly reliability is not as valuable as validity, but it is easier to assess reliability in comparison to validity. If the quality of reliability is satisfied by an instrument, then while using it we can be confident that the transient and situational factors are not interfering.

Two aspects of reliability viz., stability and equivalence deserve special mention. The *stability aspect* is concerned with securing consistent results with repeated measurements of the same person and with the same instrument. We usually determine the degree of stability by comparing the results of repeated measurements. The *equivalence aspect* considers how much error may get introduced by different investigators or different samples of the items being studied. A good way to test for the equivalence of measurements by two investigators is to compare their observations of the same events. Reliability can be improved in the following two ways:

(i) By standardising the conditions under which the measurement takes place i.e., we must ensure that external sources of variation such as boredom, fatigue, etc., are minimised to the extent possible. That will improve stability aspect.

(ii) By carefully designed directions for measurement with no variation from group to group, by using trained and motivated persons to conduct the research and also by broadening the sample of items used. This will improve equivalence aspect.

3. Test of Practicality

The practicality characteristic of a measuring instrument can be judged in terms of economy, convenience and interpretability. From the operational point of view, the measuring instrument ought to be practical i.e., it should be economical, convenient and interpretable. *Economy* consideration suggests that some trade-off is needed between the ideal research project and that which the budget can afford. The length of measuring instrument is an important area where economic pressures are quickly felt. Although more items give greater reliability as stated earlier, but in the interest of limiting the interview or observation time, we have to take only few items for our study purpose. Similarly, data-collection methods to be used are also dependent at times upon economic factors. *Convenience* test suggests that the measuring instrument should be easy to administer. For this purpose one should give due attention to the proper layout of the measuring instrument. For instance, a questionnaire, with clear instructions (illustrated by examples), is certainly more effective and easier to complete than one which lacks these features. *Interpretability* consideration is specially important when persons other than the designers of the test are to interpret the results. The measuring instrument, in order to be interpretable, must be supplemented by (a) detailed instructions for administering the test; (b) scoring keys; (c) evidence about the reliability and (d) guides for using the test and for interpreting results.

TECHNIQUE OF DEVELOPING MEASUREMENT TOOLS

The technique of developing measurement tools involves a four-stage process, consisting of the following:

(a) Concept development;
(b) Specification of concept dimensions;
(c) Selection of indicators; and
(d) Formation of index.

The first and foremost step is that of *concept development* which means that the researcher should arrive at an understanding of the major concepts pertaining to his study. This step of concept

development is more apparent in theoretical studies than in the more pragmatic research, where the fundamental concepts are often already established.

The second step requires the researcher to specify the *dimensions of the concepts* that he developed in the first stage. This task may either be accomplished by deduction i.e., by adopting a more or less intuitive approach or by empirical correlation of the individual dimensions with the total concept and/or the other concepts. For instance, one may think of several dimensions such as product reputation, customer treatment, corporate leadership, concern for individuals, sense of social responsibility and so forth when one is thinking about the image of a certain company.

Once the dimensions of a concept have been specified, the researcher must *develop indicators* for measuring each concept element. Indicators are specific questions, scales, or other devices by which respondent's knowledge, opinion, expectation, etc., are measured. As there is seldom a perfect measure of a concept, the researcher should consider several alternatives for the purpose. The use of more than one indicator gives stability to the scores and it also improves their validity.

The last step is that of combining the various indicators into an index, i.e., *formation of an index.* When we have several dimensions of a concept or different measurements of a dimension, we may need to combine them into a single index. One simple way for getting an overall index is to provide scale values to the responses and then sum up the corresponding scores. Such an overall index would provide a better measurement tool than a single indicator because of the fact that an "individual indicator has only a probability relation to what we really want to know."[2] This way we must obtain an overall index for the various concepts concerning the research study.

Scaling

In research we quite often face measurement problem (since we want a valid measurement but may not obtain it), specially when the concepts to be measured are complex and abstract and we do not possess the standardised measurement tools. Alternatively, we can say that while measuring attitudes and opinions, we face the problem of their valid measurement. Similar problem may be faced by a researcher, of course in a lesser degree, while measuring physical or institutional concepts. As such we should study some procedures which may enable us to measure abstract concepts more accurately. This brings us to the study of scaling techniques.

Meaning of Scaling

Scaling describes the procedures of assigning numbers to various degrees of opinion, attitude and other concepts. This can be done in two ways viz., (i) making a judgement about some characteristic of an individual and then placing him directly on a scale that has been defined in terms of that characteristic and (ii) constructing questionnaires in such a way that the score of individual's responses assigns him a place on a scale. It may be stated here that a scale is a continuum, consisting of the highest point (in terms of some characteristic e.g., preference, favourableness, etc.) and the lowest point along with several intermediate points between these two extreme points. These scale-point positions are so related to each other that when the first point happens to be the highest point, the second point indicates a higher degree in terms of a given characteristic as compared to the third

[2] Lazersfeld, *Evidence and Inference,* p. 112.

point and the third point indicates a higher degree as compared to the fourth and so on. Numbers for measuring the distinctions of degree in the attitudes/opinions are, thus, assigned to individuals corresponding to their scale-positions. All this is better understood when we talk about scaling technique(s). Hence the term 'scaling' is applied to the procedures for attempting to determine quantitative measures of subjective abstract concepts. Scaling has been defined as a "procedure for the assignment of numbers (or other symbols) to a property of objects in order to impart some of the characteristics of numbers to the properties in question."[3]

Scale Classification Bases

The number assigning procedures or the scaling procedures may be broadly classified on one or more of the following bases: (a) subject orientation; (b) response form; (c) degree of subjectivity; (d) scale properties; (e) number of dimensions and (f) scale construction techniques. We take up each of these separately.

(a) Subject orientation: Under it a scale may be designed to measure characteristics of the respondent who completes it or to judge the stimulus object which is presented to the respondent. In respect of the former, we presume that the stimuli presented are sufficiently homogeneous so that the between-stimuli variation is small as compared to the variation among respondents. In the latter approach, we ask the respondent to judge some specific object in terms of one or more dimensions and we presume that the between-respondent variation will be small as compared to the variation among the different stimuli presented to respondents for judging.

(b) Response form: Under this we may classify the scales as categorical and comparative. Categorical scales are also known as rating scales. These scales are used when a respondent scores some object without direct reference to other objects. Under comparative scales, which are also known as ranking scales, the respondent is asked to compare two or more objects. In this sense the respondent may state that one object is superior to the other or that three models of pen rank in order 1, 2 and 3. The essence of ranking is, in fact, a relative comparison of a certain property of two or more objects.

(c) Degree of subjectivity: With this basis the scale data may be based on whether we measure subjective personal preferences or simply make non-preference judgements. In the former case, the respondent is asked to choose which person he favours or which solution he would like to see employed, whereas in the latter case he is simply asked to judge which person is more effective in some aspect or which solution will take fewer resources without reflecting any personal preference.

(d) Scale properties: Considering scale properties, one may classify the scales as nominal, ordinal, interval and ratio scales. Nominal scales merely classify without indicating order, distance or unique origin. Ordinal scales indicate magnitude relationships of 'more than' or 'less than', but indicate no distance or unique origin. Interval scales have both order and distance values, but no unique origin. Ratio scales possess all these features.

(e) Number of dimensions: In respect of this basis, scales can be classified as 'unidimensional' and 'multidimensional' scales. Under the former we measure only one attribute of the respondent or object, whereas multidimensional scaling recognizes that an object might be described better by using the concept of an attribute space of 'n' dimensions, rather than a single-dimension continuum.

[3] Bernard S. Phillips, *Social Research Strategy and Tactics*, 2nd ed., p. 205.

(f) Scale construction techniques: Following are the five main techniques by which scales can be developed.

(i) *Arbitrary approach:* It is an approach where scale is developed on *ad hoc* basis. This is the most widely used approach. It is presumed that such scales measure the concepts for which they have been designed, although there is little evidence to support such an assumption.

(ii) *Consensus approach:* Here a panel of judges evaluate the items chosen for inclusion in the instrument in terms of whether they are relevant to the topic area and unambiguous in implication.

(iii) *Item analysis approach:* Under it a number of individual items are developed into a test which is given to a group of respondents. After administering the test, the total scores are calculated for every one. Individual items are then analysed to determine which items discriminate between persons or objects with high total scores and those with low scores.

(iv) *Cumulative scales* are chosen on the basis of their conforming to some ranking of items with ascending and descending discriminating power. For instance, in such a scale the endorsement of an item representing an extreme position should also result in the endorsement of all items indicating a less extreme position.

(v) *Factor scales* may be constructed on the basis of intercorrelations of items which indicate that a common factor accounts for the relationship between items. This relationship is typically measured through factor analysis method.

Important Scaling Techniques

We now take up some of the important scaling techniques often used in the context of research specially in context of social or business research.

Rating scales: The rating scale involves qualitative description of a limited number of aspects of a thing or of traits of a person. When we use rating scales (or categorical scales), we judge an object in absolute terms against some specified criteria i.e., we judge properties of objects without reference to other similar objects. These ratings may be in such forms as "like-dislike", "above average, average, below average", or other classifications with more categories such as "like very much—like some what—neutral—dislike somewhat—dislike very much"; "excellent—good—average—below average—poor", "always—often—occasionally—rarely—never", and so on. There is no specific rule whether to use a two-points scale, three-points scale or scale with still more points. In practice, three to seven points scales are generally used for the simple reason that more points on a scale provide an opportunity for greater sensitivity of measurement.

Rating scale may be either a graphic rating scale or an itemized rating scale.

(i) *The graphic rating scale* is quite simple and is commonly used in practice. Under it the various points are usually put along the line to form a continuum and the rater indicates his rating by simply making a mark (such as ✓) at the appropriate point on a line that runs from one extreme to the other. Scale-points with brief descriptions may be indicated along the line, their function being to assist the rater in performing his job. The following is an example of five-points graphic rating scale when we wish to ascertain people's liking or disliking any product:

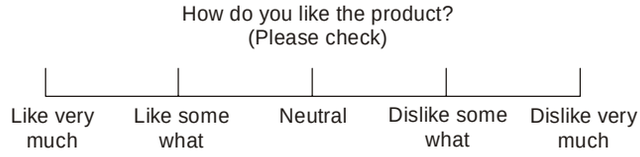


Fig. 5.1

This type of scale has several limitations. The respondents may check at almost any position along the line which fact may increase the difficulty of analysis. The meanings of the terms like "very much" and "some what" may depend upon respondent's frame of reference so much so that the statement might be challenged in terms of its equivalency. Several other rating scale variants (e.g., boxes replacing line) may also be used.

(ii) The *itemized rating scale* (also known as numerical scale) presents a series of statements from which a respondent selects one as best reflecting his evaluation. These statements are ordered progressively in terms of more or less of some property. An example of itemized scale can be given to illustrate it.

Suppose we wish to inquire as to how well does a worker get along with his fellow workers? In such a situation we may ask the respondent to select one, to express his opinion, from the following:

- He is almost always involved in some friction with a fellow worker.
- He is often at odds with one or more of his fellow workers.
- He sometimes gets involved in friction.
- He infrequently becomes involved in friction with others.
- He almost never gets involved in friction with fellow workers.

The chief merit of this type of scale is that it provides more information and meaning to the rater, and thereby increases reliability. This form is relatively difficult to develop and the statements may not say exactly what the respondent would like to express.

Rating scales have certain good points. The results obtained from their use compare favourably with alternative methods. They require less time, are interesting to use and have a wide range of applications. Besides, they may also be used with a large number of properties or variables. But their value for measurement purposes depends upon the assumption that the respondents can and do make good judgements. If the respondents are not very careful while rating, errors may occur. Three types of errors are common viz., the error of leniency, the error of central tendency and the error of hallo effect. The error of leniency occurs when certain respondents are either easy raters or hard raters. When raters are reluctant to give extreme judgements, the result is the error of central tendency. The error of hallo effect or the systematic bias occurs when the rater carries over a generalised impression of the subject from one rating to another. This sort of error takes place when we conclude for example, that a particular report is good because we like its form or that someone is intelligent because he agrees with us or has a pleasing personality. In other words, hallo effect is likely to appear when the rater is asked to rate many factors, on a number of which he has no evidence for judgement.

Ranking scales: Under ranking scales (or comparative scales) we make relative judgements against other similar objects. The respondents under this method directly compare two or more objects and make choices among them. There are two generally used approaches of ranking scales viz.

(a) Method of paired comparisons: Under it the respondent can express his attitude by making a choice between two objects, say between a new flavour of soft drink and an established brand of drink. But when there are more than two stimuli to judge, the number of judgements required in a paired comparison is given by the formula:

$$N = \frac{n(n-1)}{2}$$

where N = number of judgements

n = number of stimuli or objects to be judged.

For instance, if there are ten suggestions for bargaining proposals available to a workers union, there are 45 paired comparisons that can be made with them. When N happens to be a big figure, there is the risk of respondents giving ill considered answers or they may even refuse to answer. We can reduce the number of comparisons per respondent either by presenting to each one of them only a sample of stimuli or by choosing a few objects which cover the range of attractiveness at about equal intervals and then comparing all other stimuli to these few standard objects. Thus, paired-comparison data may be treated in several ways. If there is substantial consistency, we will find that if *X* is preferred to *Y*, and *Y* to *Z*, then *X* will consistently be preferred to *Z*. If this is true, we may take the total number of preferences among the comparisons as the score for that stimulus.

It should be remembered that paired comparison provides ordinal data, but the same may be converted into an interval scale by the method of the *Law of Comparative Judgement* developed by L.L. Thurstone. This technique involves the conversion of frequencies of preferences into a table of proportions which are then transformed into *Z* matrix by referring to the table of area under the normal curve. J.P. Guilford in his book "Psychometric Methods" has given a procedure which is relatively easier. The method is known as the *Composite Standard Method* and can be illustrated as under:

Suppose there are four proposals which some union bargaining committee is considering. The committee wants to know how the union membership ranks these proposals. For this purpose a sample of 100 members might express the views as shown in the following table:

Table 5.1: Response Patterns of 100 Members' Paired Comparisons of 4 Suggestions for Union Bargaining Proposal Priorities

	Suggestion			
	A	*B*	*C*	*D*
A	–	65*	32	20
B	40	–	38	42
C	45	50	–	70
D	80	20	98	–
TOTAL:	165	135	168	132

Contd.

*Read as 65 members preferred suggestion *B* to suggestion *A*.

Rank order	2	3	1	4
M_p	0.5375	0.4625	0.5450	0.4550
Z_j	0.09	(–).09	0.11	(–).11
R_j	0.20	0.02	0.22	0.00

Comparing the total number of preferences for each of the four proposals, we find that *C* is the most popular, followed by *A*, *B* and *D* respectively in popularity. The rank order shown in the above table explains all this.

By following the composite standard method, we can develop an interval scale from the paired-comparison ordinal data given in the above table for which purpose we have to adopt the following steps in order:

(i) Using the data in the above table, we work out the column mean with the help of the formula given below:

$$M_p = \frac{C + .5(N)}{nN} = \frac{165 + .5(100)}{4(100)} = .5375$$

where

M_p = the mean proportion of the columns

C = the total number of choices for a given suggestion

n = number of stimuli (proposals in the given problem)

N = number of items in the sample.

The column means have been shown in the M_p row in the above table.

(ii) The *Z* values for the M_p are secured from the table giving the area under the normal curve. When the M_p value is less than .5, the *Z* value is negative and for all M_p values higher than .5, the *Z* values are positive.* These Z values are shown in Z_j row in the above table.

(iii) As the Z_j values represent an interval scale, zero is an arbitrary value. Hence we can eliminate negative scale values by giving the value of zero to the lowest scale value (this being (–).11 in our example which we shall take equal to zero) and then adding the absolute value of this lowest scale value to all other scale items. This scale has been shown in R_j row in the above table.

Graphically we can show this interval scale that we have derived from the paired-comparison data using the composite standard method as follows:

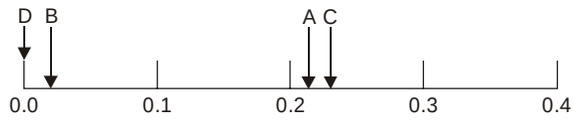


Fig. 5.2

* To use Normal curve area table for this sort of transformation, we must subtract 0.5 from all M_p values which exceed .5 to secure the values with which to enter the normal curve area table for which *Z* values can be obtained. For all M_p values of less than . 5 we must subtract all such values from 0.5 to secure the values with which to enter the normal curve area table for which *Z* values can be obtained but the *Z* values in this situation will be with negative sign.

(b) Method of rank order: Under this method of comparative scaling, the respondents are asked to rank their choices. This method is easier and faster than the method of paired comparisons stated above. For example, with 10 items it takes 45 pair comparisons to complete the task, whereas the method of rank order simply requires ranking of 10 items only. The problem of transitivity (such as *A* prefers to *B*, *B* to *C*, but *C* prefers to *A*) is also not there in case we adopt method of rank order. Moreover, a complete ranking at times is not needed in which case the respondents may be asked to rank only their first, say, four choices while the number of overall items involved may be more than four, say, it may be 15 or 20 or more. To secure a simple ranking of all items involved we simply total rank values received by each item. There are methods through which we can as well develop an interval scale of these data. But then there are limitations of this method. The first one is that data obtained through this method are ordinal data and hence rank ordering is an ordinal scale with all its limitations. Then there may be the problem of respondents becoming careless in assigning ranks particularly when there are many (usually more than 10) items.

Scale Construction Techniques

In social science studies, while measuring attitudes of the people we generally follow the technique of preparing the opinionnaire* (or attitude scale) in such a way that the score of the individual responses assigns him a place on a scale. Under this approach, the respondent expresses his agreement or disagreement with a number of statements relevant to the issue. While developing such statements, the researcher must note the following two points:

(i) That the statements must elicit responses which are psychologically related to the attitude being measured;

(ii) That the statements need be such that they discriminate not merely between extremes of attitude but also among individuals who differ slightly.

Researchers must as well be aware that inferring attitude from what has been recorded in opinionnaires has several limitations. People may conceal their attitudes and express socially acceptable opinions. They may not really know how they feel about a social issue. People may be unaware of their attitude about an abstract situation; until confronted with a real situation, they may be unable to predict their reaction. Even behaviour itself is at times not a true indication of attitude. For instance, when politicians kiss babies, their behaviour may not be a true expression of affection toward infants. Thus, there is no sure method of measuring attitude; we only try to measure the expressed opinion and then draw inferences from it about people's real feelings or attitudes.

With all these limitations in mind, psychologists and sociologists have developed several scale construction techniques for the purpose. The researcher should know these techniques so as to develop an appropriate scale for his own study. Some of the important approaches, along with the corresponding scales developed under each approach to measure attitude are as follows:

* An information form that attempts to measure the attitude or belief of an individual is known as opinionnaire.

Table 5.2: Different Scales for Measuring Attitudes of People

Name of the scale construction approach	*Name of the scale developed*
1. Arbitrary approach	Arbitrary scales
2. Consensus scale approach	Differential scales (such as Thurstone Differential scale)
3. Item analysis approach	Summated scales (such as Likert Scale)
4. Cumulative scale approach	Cumulative scales (such as Guttman's Scalogram)
5. Factor analysis approach	Factor scales (such as Osgood's Semantic Differential, Multi-dimensional Scaling, etc.)

A brief description of each of the above listed scales will be helpful.

Arbitrary Scales

Arbitrary scales are developed on *ad hoc* basis and are designed largely through the researcher's own subjective selection of items. The researcher first collects few statements or items which he believes are unambiguous and appropriate to a given topic. Some of these are selected for inclusion in the measuring instrument and then people are asked to check in a list the statements with which they agree.

The chief merit of such scales is that they can be developed very easily, quickly and with relatively less expense. They can also be designed to be highly specific and adequate. Because of these benefits, such scales are widely used in practice.

At the same time there are some limitations of these scales. The most important one is that we do not have objective evidence that such scales measure the concepts for which they have been developed. We have simply to rely on researcher's insight and competence.

Differential Scales (or Thurstone-type Scales)

The name of L.L. Thurstone is associated with differential scales which have been developed using consensus scale approach. Under such an approach the selection of items is made by a panel of judges who evaluate the items in terms of whether they are relevant to the topic area and unambiguous in implication. The detailed procedure is as under:

(a) The researcher gathers a large number of statements, usually twenty or more, that express various points of view toward a group, institution, idea, or practice (i.e., statements belonging to the topic area).

(b) These statements are then submitted to a panel of judges, each of whom arranges them in eleven groups or piles ranging from one extreme to another in position. Each of the judges is requested to place generally in the first pile the statements which he thinks are most unfavourable to the issue, in the second pile to place those statements which he thinks are next most unfavourable and he goes on doing so in this manner till in the eleventh pile he puts the statements which he considers to be the most favourable.

(c) This sorting by each judge yields a composite position for each of the items. In case of marked disagreement between the judges in assigning a position to an item, that item is discarded.

(d) For items that are retained, each is given its median scale value between one and eleven as established by the panel. In other words, the scale value of any one statement is computed as the 'median' position to which it is assigned by the group of judges.

(e) A final selection of statements is then made. For this purpose a sample of statements, whose median scores are spread evenly from one extreme to the other is taken. The statements so selected, constitute the final scale to be administered to respondents. The position of each statement on the scale is the same as determined by the judges.

After developing the scale as stated above, the respondents are asked during the administration of the scale to check the statements with which they agree. The median value of the statements that they check is worked out and this establishes their score or quantifies their opinion. It may be noted that in the actual instrument the statements are arranged in random order of scale value. If the values are valid and if the opinionnaire deals with only one attitude dimension, the typical respondent will choose one or several contiguous items (in terms of scale values) to reflect his views. However, at times divergence may occur when a statement appears to tap a different attitude dimension.

The Thurstone method has been widely used for developing differential scales which are utilised to measure attitudes towards varied issues like war, religion, etc. Such scales are considered most appropriate and reliable when used for measuring a single attitude. But an important deterrent to their use is the cost and effort required to develop them. Another weakness of such scales is that the values assigned to various statements by the judges may reflect their own attitudes. The method is not completely objective; it involves ultimately subjective decision process. Critics of this method also opine that some other scale designs give more information about the respondent's attitude in comparison to differential scales.

Summated Scales (or Likert-type Scales)

Summated scales (or Likert-type scales) are developed by utilizing the item analysis approach wherein a particular item is evaluated on the basis of how well it discriminates between those persons whose total score is high and those whose score is low. Those items or statements that best meet this sort of discrimination test are included in the final instrument.

Thus, summated scales consist of a number of statements which express either a favourable or unfavourable attitude towards the given object to which the respondent is asked to react. The respondent indicates his agreement or disagreement with each statement in the instrument. Each response is given a numerical score, indicating its favourableness or unfavourableness, and the scores are totalled to measure the respondent's attitude. In other words, the overall score represents the respondent's position on the continuum of favourable-unfavourableness towards an issue.

Most frequently used summated scales in the study of social attitudes follow the pattern devised by Likert. For this reason they are often referred to as Likert-type scales. In a Likert scale, the respondent is asked to respond to each of the statements in terms of several degrees, usually five degrees (but at times 3 or 7 may also be used) of agreement or disagreement. For example, when asked to express opinion whether one considers his job quite pleasant, the respondent may respond in any one of the following ways: (i) strongly agree, (ii) agree, (iii) undecided, (iv) disagree, (v) strongly disagree.

We find that these five points constitute the scale. At one extreme of the scale there is strong agreement with the given statement and at the other, strong disagreement, and between them lie intermediate points. We may illustrate this as under:

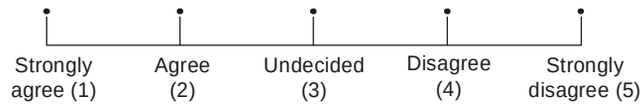


Fig. 5.3

Each point on the scale carries a score. Response indicating the least favourable degree of job satisfaction is given the least score (say 1) and the most favourable is given the highest score (say 5). These score—values are normally not printed on the instrument but are shown here just to indicate the scoring pattern. The Likert scaling technique, thus, assigns a scale value to each of the five responses. The same thing is done in respect of each and every statement in the instrument. This way the instrument yields a total score for each respondent, which would then measure the respondent's favourableness toward the given point of view. If the instrument consists of, say 30 statements, the following score values would be revealing.

$30 \times 5 = 150$ Most favourable response possible

$30 \times 3 = 90$ A neutral attitude

$30 \times 1 = 30$ Most unfavourable attitude.

The scores for any individual would fall between 30 and 150. If the score happens to be above 90, it shows favourable opinion to the given point of view, a score of below 90 would mean unfavourable opinion and a score of exactly 90 would be suggestive of a neutral attitude.

Procedure: The procedure for developing a Likert-type scale is as follows:

(i) As a first step, the researcher collects a large number of statements which are relevant to the attitude being studied and each of the statements expresses definite favourableness or unfavourableness to a particular point of view or the attitude and that the number of favourable and unfavourable statements is approximately equal.

(ii) After the statements have been gathered, a trial test should be administered to a number of subjects. In other words, a small group of people, from those who are going to be studied finally, are asked to indicate their response to each statement by checking one of the categories of agreement or disagreement using a five point scale as stated above.

(iii) The response to various statements are scored in such a way that a response indicative of the most favourable attitude is given the highest score of 5 and that with the most unfavourable attitude is given the lowest score, say, of 1.

(iv) Then the total score of each respondent is obtained by adding his scores that he received for separate statements.

(v) The next step is to array these total scores and find out those statements which have a high discriminatory power. For this purpose, the researcher may select some part of the highest and the lowest total scores, say the top 25 per cent and the bottom 25 per cent. These two extreme groups are interpreted to represent the most favourable and the least favourable attitudes and are used as criterion groups by which to evaluate individual statements. This

way we determine which statements consistently correlate with low favourability and which with high favourability.

(vi) Only those statements that correlate with the total test should be retained in the final instrument and all others must be discarded from it.

Advantages: The Likert-type scale has several advantages. Mention may be made of the important ones.

(a) It is relatively easy to construct the Likert-type scale in comparison to Thurstone-type scale because Likert-type scale can be performed without a panel of judges.

(b) Likert-type scale is considered more reliable because under it respondents answer each statement included in the instrument. As such it also provides more information and data than does the Thurstone-type scale.

(c) Each statement, included in the Likert-type scale, is given an empirical test for discriminating ability and as such, unlike Thurstone-type scale, the Likert-type scale permits the use of statements that are not manifestly related (to have a direct relationship) to the attitude being studied.

(d) Likert-type scale can easily be used in respondent-centred and stimulus-centred studies i.e., through it we can study how responses differ between people and how responses differ between stimuli.

(e) Likert-type scale takes much less time to construct, it is frequently used by the students of opinion research. Moreover, it has been reported in various research studies* that there is high degree of correlation between Likert-type scale and Thurstone-type scale.

Limitations: There are several limitations of the Likert-type scale as well. One important limitation is that, with this scale, we can simply examine whether respondents are more or less favourable to a topic, but we cannot tell how much more or less they are. There is no basis for belief that the five positions indicated on the scale are equally spaced. The interval between 'strongly agree' and 'agree', may not be equal to the interval between "agree" and "undecided". This means that Likert scale does not rise to a stature more than that of an ordinal scale, whereas the designers of Thurstone scale claim the Thurstone scale to be an interval scale. One further disadvantage is that often the total score of an individual respondent has little clear meaning since a given total score can be secured by a variety of answer patterns. It is unlikely that the respondent can validly react to a short statement on a printed form in the absence of real-life qualifying situations. Moreover, there "remains a possibility that people may answer according to what they think they should feel rather than how they do feel."[4] This particular weakness of the Likert-type scale is met by using a cumulative scale which we shall take up later in this chapter.

In spite of all the limitations, the Likert-type summated scales are regarded as the most useful in a situation wherein it is possible to compare the respondent's score with a distribution of scores from some well defined group. They are equally useful when we are concerned with a programme of

*A.L. Edwards and K.C. Kenney, "A comparison of the Thurstone and Likert techniques of attitude scale construction", *Journal of Applied Psychology*, 30, 72–83, 1946.

[4] John W. Best and James V. Kahn, "Research in Education", 5 ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 1986, p. 183.

change or improvement in which case we can use the scales to measure attitudes before and after the programme of change or improvement in order to assess whether our efforts have had the desired effects. We can as well correlate scores on the scale to other measures without any concern for the absolute value of what is favourable and what is unfavourable. All this accounts for the popularity of Likert-type scales in social studies relating to measuring of attitudes.

Cumulative scales: Cumulative scales or Louis Guttman's scalogram analysis, like other scales, consist of series of statements to which a respondent expresses his agreement or disagreement. The special feature of this type of scale is that statements in it form a cumulative series. This, in other words, means that the statements are related to one another in such a way that an individual, who replies favourably to say item No. 3, also replies favourably to items No. 2 and 1, and one who replies favourably to item No. 4 also replies favourably to items No. 3, 2 and 1, and so on. This being so an individual whose attitude is at a certain point in a cumulative scale will answer favourably all the items on one side of this point, and answer unfavourably all the items on the other side of this point. The individual's score is worked out by counting the number of points concerning the number of statements he answers favourably. If one knows this total score, one can estimate as to how a respondent has answered individual statements constituting cumulative scales. The major scale of this type of cumulative scales is the Guttman's scalogram. We attempt a brief description of the same below.

The technique developed by Louis Guttman is known as scalogram analysis, or at times simply 'scale analysis'. Scalogram analysis refers to the procedure for determining whether a set of items forms a unidimensional scale. A scale is said to be unidimensional if the responses fall into a pattern in which endorsement of the item reflecting the extreme position results also in endorsing all items which are less extreme. Under this technique, the respondents are asked to indicate in respect of each item whether they agree or disagree with it, and if these items form a unidimensional scale, the response pattern will be as under:

Table 5.3: Response Pattern in Scalogram Analysis

Item Number				*Respondent Score*
4	*3*	*2*	*1*	
X	X	X	X	4
–	X	X	X	3
–	–	X	X	2
–	–	–	X	1
–	–	–	–	0

X = Agree

– = Disagree

A score of 4 means that the respondent is in agreement with all the statements which is indicative of the most favourable attitude. But a score of 3 would mean that the respondent is not agreeable to item 4, but he agrees with all others. In the same way one can interpret other values of the respondents' scores. This pattern reveals that the universe of content is scalable.

Procedure: The procedure for developing a scalogram can be outlined as under:

(a) The universe of content must be defined first of all. In other words, we must lay down in clear terms the issue we want to deal within our study.

(b) The next step is to develop a number of items relating the issue and to eliminate by inspection the items that are ambiguous, irrelevant or those that happen to be too extreme items.

(c) The third step consists in pre-testing the items to determine whether the issue at hand is scalable (The pretest, as suggested by Guttman, should include 12 or more items, while the final scale may have only 4 to 6 items. Similarly, the number of respondents in a pretest may be small, say 20 or 25 but final scale should involve relatively more respondents, say 100 or more).

In a pretest the respondents are asked to record their opinions on all selected items using a Likert-type 5-point scale, ranging from 'strongly agree' to 'strongly disagree'. The strongest favourable response is scored as 5, whereas the strongest unfavourable response as 1. The total score can thus range, if there are 15 items in all, from 75 for most favourable to 15 for the least favourable.

Respondent opinionnaires are then arrayed according to total score for analysis and evaluation. If the responses of an item form a cumulative scale, its response category scores should decrease in an orderly fashion as indicated in the above table. Failure to show the said decreasing pattern means that there is overlapping which shows that the item concerned is not a good cumulative scale item i.e., the item has more than one meaning. Sometimes the overlapping in category responses can be reduced by combining categories. After analysing the pretest results, a few items, say 5 items, may be chosen.

(d) The next step is again to total the scores for the various opinionnaires, and to rearray them to reflect any shift in order, resulting from reducing the items, say, from 15 in pretest to, say, 5 for the final scale. The final pretest results may be tabulated in the form of a table given in Table 5.4.

Table 5.4: The Final Pretest Results in a Scalogram Analysis*

Scale type	*Item*					*Errors per case*	*Number of cases*	*Number of errors*
	5	*12*	*3*	*10*	*7*			
5 (perfect)	X	X	X	X	X	0	7	0
4 (perfect)	–	X	X	X	X	0	3	0
(nonscale)	–	X	–	X	X	1	1	1
(nonscale)	–	X	X	–	X	1	2	2
3 (perfect)	–	–	X	X	X	0	5	0
2 (perfect)	–	–	–	X	X	0	2	0
1 (perfect)	–	–	–	–	X	0	1	0
(nonscale)	–	–	X	–	–	2	1	2
(nonscale)	–	–	X	–	–	2	1	2
0 (perfect)	–	–	–	–	–	0	2	0
			$n = 5$				$N = 25$	$e = 7$

* (Figures in the table are arbitrary and have been used to explain the tabulation process only.)

The table shows that five items (numbering 5, 12, 3, 10 and 7) have been selected for the final scale. The number of respondents is 25 whose responses to various items have been tabulated along with the number of errors. Perfect scale types are those in which the respondent's answers fit the pattern that would be reproduced by using the person's total score as a guide. *Non-scale types* are those in which the category pattern differs from that expected from the respondent's total score i.e., non-scale cases have deviations from unidimensionality or errors. Whether the items (or series of statements) selected for final scale may be regarded a perfect cumulative (or a unidimensional scale), we have to examine on the basis of the coefficient of reproducibility. Guttman has set 0.9 as the level of minimum reproducibility in order to say that the scale meets the test of unidimensionality. He has given the following formula for measuring the level of reproducibility:

Guttman's Coefficient of Reproducibility = $1 - e/n(N)$

where e = number of errors

n = number of items

N = number of cases

For the above table figures,

Coefficient of Reproducibility = $1 - 7/5(25) = .94$

This shows that items number 5, 12, 3, 10 and 7 in this order constitute the cumulative or unidimensional scale, and with this we can reproduce the responses to each item, knowing only the total score of the respondent concerned.

Scalogram, analysis, like any other scaling technique, has several advantages as well as limitations. One advantage is that it assures that only a single dimension of attitude is being measured. Researcher's subjective judgement is not allowed to creep in the development of scale since the scale is determined by the replies of respondents. Then, we require only a small number of items that make such a scale easy to administer. Scalogram analysis can appropriately be used for personal, telephone or mail surveys. The main difficulty in using this scaling technique is that in practice perfect cumulative or unidimensional scales are very rarely found and we have only to use its approximation testing it through coefficient of reproducibility or examining it on the basis of some other criteria. This method is not a frequently used method for the simple reason that its development procedure is tedious and complex. Such scales hardly constitute a reliable basis for assessing attitudes of persons towards complex objects for predicting the behavioural responses of individuals towards such objects. Conceptually, this analysis is a bit more difficult in comparison to other scaling methods.

Factor Scales[*]

Factor scales are developed through factor analysis or on the basis of intercorrelations of items which indicate that a common factor accounts for the relationships between items. Factor scales are particularly "useful in uncovering latent attitude dimensions and approach scaling through the concept of multiple-dimension attribute space."[5] More specifically the two problems viz., how to deal

[*] A detailed study of the factor scales and particularly the statistical procedures involved in developing factor scales is beyond the scope of this book. As such only an introductory idea of factor scales is presented here.

[5] C. William Emory, *Business Research Methods*, p. 264–65.

appropriately with the universe of content which is multi-dimensional and how to uncover underlying (latent) dimensions which have not been identified, are dealt with through factor scales. An important factor scale based on factor analysis is *Semantic Differential* (*S.D.*) and the other one is *Multidimensional Scaling*. We give below a brief account of these factor scales.

Semantic differential scale: Semantic differential scale or the S.D. scale developed by Charles E. Osgood, G.J. Suci and P.H. Tannenbaum (1957), is an attempt to measure the psychological meanings of an object to an individual. This scale is based on the presumption that an object can have different dimensions of connotative meanings which can be located in multidimensional property space, or what can be called the semantic space in the context of S.D. scale. This scaling consists of a set of bipolar rating scales, usually of 7 points, by which one or more respondents rate one or more concepts on each scale item. For instance, the S.D. scale items for analysing candidates for leadership position may be shown as under:

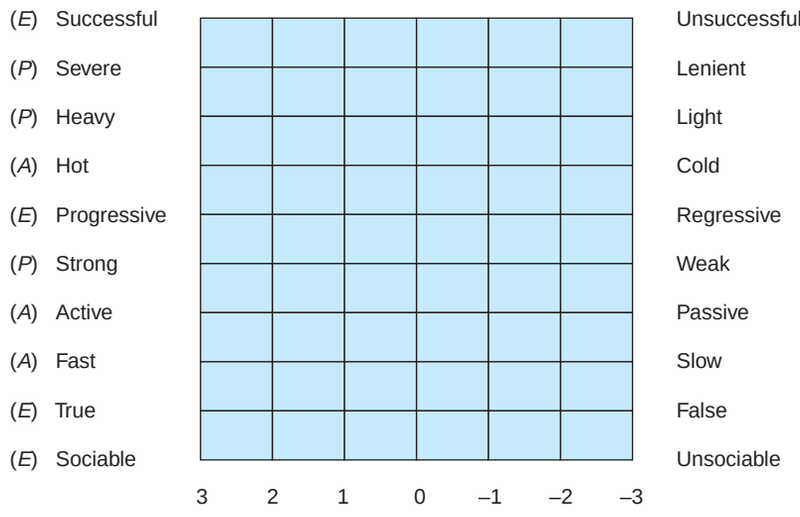


Fig. 5.4

Candidates for leadership position (along with the concept—the 'ideal' candidate) may be compared and we may score them from +3 to –3 on the basis of the above stated scales. (The letters, *E*, *P*, *A* showing the relevant factor viz., evaluation, potency and activity respectively, written along the left side are not written in actual scale. Similarly the numeric values shown are also not written in actual scale.)

Osgood and others did produce a list of some adjective pairs for attitude research purposes and concluded that semantic space is multidimensional rather than unidimensional. They made sincere efforts and ultimately found that three factors, viz., evaluation, potency and activity, contributed most to meaningful judgements by respondents. The evaluation dimension generally accounts for 1/2 and 3/4 of the extractable variance and the other two factors account for the balance.

Procedure: Various steps involved in developing S.D. scale are as follows:

(a) First of all the concepts to be studied are selected. The concepts are usually chosen by personal judgement, keeping in view the nature of the problem.

(b) The next step is to select the scales bearing in mind the criterion of factor composition and the criterion of scale's relevance to the concepts being judged (it is common practice to use at least three scales for each factor with the help of which an average factor score has to be worked out). One more criterion to be kept in view is that scales should be stable across subjects and concepts.

(c) Then a panel of judges are used to rate the various stimuli (or objects) on the various selected scales and the responses of all judges would then be combined to determine the composite scaling.

To conclude, "the S.D. has a number of specific advantages. It is an efficient and easy way to secure attitudes from a large sample. These attitudes may be measured in both direction and intensity. The total set of responses provides a comprehensive picture of the meaning of an object, as well as a measure of the subject doing the rating. It is a standardised technique that is easily repeated, but escapes many of the problems of response distortion found with more direct methods."[6]

Multidimensional scaling: Multidimensional scaling (MDS) is relatively more complicated scaling device, but with this sort of scaling one can scale objects, individuals or both with a minimum of information. Multidimensional scaling (or MDS) can be characterized as a set of procedures for portraying perceptual or affective dimensions of substantive interest. It "provides useful methodology for portraying subjective judgements of diverse kinds."[7] MDS is used when all the variables (whether metric or non-metric) in a study are to be analyzed simultaneously and all such variables happen to be independent. The underlying assumption in MDS is that people (respondents) "perceive a set of objects as being more or less similar to one another on a number of dimensions (usually uncorrelated with one another) instead of only one."[8] Through MDS techniques one can represent geometrically the locations and interrelationships among a set of points. In fact, these techniques attempt to locate the points, given the information about a set of interpoint distances, in space of one or more dimensions such as to best summarise the information contained in the interpoint distances. The distances in the solution space then optimally reflect the distances contained in the input data. For instance, if objects, say *X* and *Y*, are thought of by the respondent as being most similar as compared to all other possible pairs of objects, MDS techniques will position objects *X* and *Y* in such a way that the distance between them in multidimensional space is shorter than that between any two other objects.

Two approaches, viz., the metric approach and the non-metric approach, are usually talked about in the context of MDS, while attempting to construct a space containing m points such that $m(m-1)/2$ interpoint distances reflect the input data. The *metric approach to MDS* treats the input data as interval scale data and solves applying statistical methods for the additive constant* which

[6] *Ibid.,* p. 260.

[7] Paul E. Green, "*Analyzing Multivariate Data*", p. 421.

[8] Jagdish N. Sheth, "The Multivariate Revolution in Marketing Research", quoted in "*Marketing Research*" by Danny N. Bellenger and Barnett A. Greenberg, p. 255.

* Additive constant refers to that constant with which one can, either by subtracting or adding, convert interval scale to a ratio scale. For instance, suppose we know that distances, say *a—b*, *b—c*, *c—d* among stimuli on a ratio scale are 7, 6 and 3 respectively. If one were to subtract 3 from each of these distances, they would be 4, 3 and 0 respectively. The converted distances would be on an interval scale of measurement, but not on a ratio scale. Obviously, one can add 3 to all the converted distances and reachieve the ratio scale of distances. Thus 3 will be taken as the additive constant in this case. Well defined iterative approach is employed in practice for estimating appropriate additive constant.

minimises the dimensionality of the solution space. This approach utilises all the information in the data in obtaining a solution. The data (i.e., the metric similarities of the objects) are often obtained on a bipolar similarity scale on which pairs of objects are rated one at a time. If the data reflect exact distances between real objects in an *r*-dimensional space, their solution will reproduce the set of interpoint distances. But as the true and real data are rarely available, we require random and systematic procedures for obtaining a solution. Generally, the judged similarities among a set of objects are statistically transformed into distances by placing those objects in a multidimensional space of some dimensionality.

The *non-metric approach* first gathers the non-metric similarities by asking respondents to rank order all possible pairs that can be obtained from a set of objects. Such non-metric data is then transformed into some arbitrary metric space and then the solution is obtained by reducing the dimensionality. In other words, this non-metric approach seeks "a representation of points in a space of minimum dimensionality such that the rank order of the interpoint distances in the solution space maximally corresponds to that of the data. This is achieved by requiring only that the distances in the solution be monotone with the input data."[9] The non-metric approach has come into prominence during the sixties with the coming into existence of high speed computers to generate metric solutions for ordinal input data.

The significance of MDS lies in the fact that it enables the researcher to study "the perceptual structure of a set of stimuli and the cognitive processes underlying the development of this structure. Psychologists, for example, employ multidimensional scaling techniques in an effort to scale psychophysical stimuli and to determine appropriate labels for the dimensions along which these stimuli vary."[10] The MDS techniques, infact, do away with the need in the data collection process to specify the attribute(s) along which the several brands, say of a particular product, may be compared as ultimately the MDS analysis itself reveals such attribute(s) that presumably underlie the expressed relative similarities among objects. Thus, MDS is an important tool in attitude measurement and the techniques falling under MDS promise "a great advance from a series of unidimensional measurements (e.g., a distribution of intensities of feeling towards single attribute such as colour, taste or a preference ranking with indeterminate intervals), to a perceptual mapping in multidimensional space of objects ... company images, advertisement brands, etc."[11]

In spite of all the merits stated above, the MDS is not widely used because of the computation complications involved under it. Many of its methods are quite laborious in terms of both the collection of data and the subsequent analyses. However, some progress has been achieved (due to the pioneering efforts of Paul Green and his associates) during the last few years in the use of non-metric MDS in the context of market research problems. The techniques have been specifically applied in "finding out the perceptual dimensions, and the spacing of stimuli along these dimensions, that people, use in making judgements about the relative similarity of pairs of Stimuli."[12] But, "in the long run, the worth of MDS will be determined by the extent to which it advances the behavioral sciences."[13]

[9] Robert Ferber (ed.), *Handbook of Marketing Research,* p. 3–51.

[10] *Ibid*., p. 3–52.

[11] G.B. Giles, *Marketing,* p. 43.

[12] Paul E. Green, *Analyzing Multivariate Data,* p. 421.

[13] Jum C. Nunnally, *Psychometric Theory*, p. 496.

Questions

1. What is the meaning of measurement in research? What difference does it make whether we measure in terms of a nominal, ordinal, interval or ratio scale? Explain giving examples.

2. Are you in agreement with the following statements? If so, give reasons:

(1) Validity is more critical to measurement than reliability.

(2) Stability and equivalence aspects of reliability essentially mean the same thing.

(3) Content validity is the most difficult type of validity to determine.

(4) There is no difference between concept development and concept specification.

(5) Reliable measurement is necessarily a valid measurement.

3. Point out the possible sources of error in measurement. Describe the tests of sound measurement.

4. Are the following nominal, ordinal, interval or ratio data? Explain your answers.

(a) Temperatures measured on the Kelvin scale.

(b) Military ranks.

(c) Social security numbers.

(d) Number of passengers on buses from Delhi to Mumbai.

(e) Code numbers given to the religion of persons attempting suicide.

5. Discuss the relative merits and demerits of:

(a) Rating vs. Ranking scales.

(b) Summated vs. Cumulative scales.

(c) Scalogram analysis *vs.* Factor analysis.

6. The following table shows the results of a paired-comparison preference test of four cold drinks from a sample of 200 persons:

Name	*Coca Cola*	*Limca*	*Goldspot*	*Thumps up*
Coca Cola	–	60*	105	45
Limca	160	–	150	70
Goldspot	75	40	–	65
Thumps up	165	120	145	–

* To be read as 60 persons preferred Limca over Coca Cola.

(a) How do these brands rank in overall preference in the given sample.

(b) Develop an interval scale for the four varieties of cold drinks.

7. (1) Narrate the procedure for developing a scalogram and illustrate the same by an example.

(2) Workout Guttman's coefficient of reproducibility from the following information:

Number of cases (N) = 30

Number of items (n) = 6

Number of errors (e) = 10

Interpret the meaning of coefficient you work out in this example.

8. Write short notes on:

(a) Semantic differential scale;

(b) Scalogram analysis;

(c) Likert-type scale;
(d) Arbitrary scales;
(e) Multidimensional scaling (MDS).

9. Describe the different methods of scale construction, pointing out the merits and demerits of each.

10. "Scaling describes the procedures by which numbers are assigned to various degrees of opinion, attitude and other concepts." Discuss. Also point out the bases for scale classification.

6

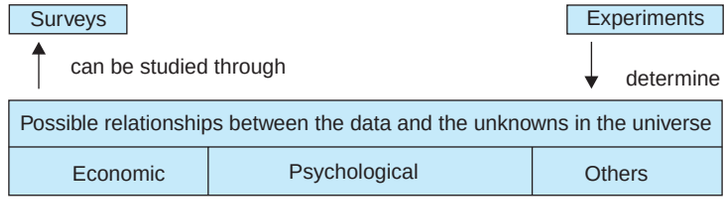
Methods of Data Collection

The task of data collection begins after a research problem has been defined and research design/plan chalked out. While deciding about the method of data collection to be used for the study, the researcher should keep in mind two types of data viz., primary and secondary. The *primary data* are those which are collected afresh and for the first time, and thus happen to be original in character. The *secondary data*, on the other hand, are those which have already been collected by someone else and which have already been passed through the statistical process. The researcher would have to decide which sort of data he would be using (thus collecting) for his study and accordingly he will have to select one or the other method of data collection. The methods of collecting primary and secondary data differ since primary data are to be originally collected, while in case of secondary data the nature of data collection work is merely that of compilation. We describe the different methods of data collection, with the pros and cons of each method.

COLLECTION OF PRIMARY DATA

We collect primary data during the course of doing experiments in an experimental research but in case we do research of the descriptive type and perform surveys, whether sample surveys or census surveys, then we can obtain primary data either through observation or through direct communication with respondents in one form or another or through personal interviews.* This, in other words, means

* An experiment refers to an investigation in which a factor or variable under test is isolated and its effect(s) measured. In an experiment the investigator measures the effects of an experiment which he conducts intentionally. Survey refers to the method of securing information concerning a phenomena under study from all or a selected number of respondents of the concerned universe. In a survey, the investigator examines those phenomena which exist in the universe independent of his action. The difference between an experiment and a survey can be depicted as under:



that there are several methods of collecting primary data, particularly in surveys and descriptive researches. Important ones are: (i) observation method, (ii) interview method, (iii) through questionnaires, (iv) through schedules, and (v) other methods which include (a) warranty cards; (b) distributor audits; (c) pantry audits; (d) consumer panels; (e) using mechanical devices; (f) through projective techniques; (g) depth interviews, and (h) content analysis. We briefly take up each method separately.

Observation Method

The observation method is the most commonly used method specially in studies relating to behavioural sciences. In a way we all observe things around us, but this sort of observation is not scientific observation. Observation becomes a scientific tool and the method of data collection for the researcher, when it serves a formulated research purpose, is systematically planned and recorded and is subjected to checks and controls on validity and reliability. Under the observation method, the information is sought by way of investigator's own direct observation without asking from the respondent. For instance, in a study relating to consumer behaviour, the investigator instead of asking the brand of wrist watch used by the respondent, may himself look at the watch. The main advantage of this method is that subjective bias is eliminated, if observation is done accurately. Secondly, the information obtained under this method relates to what is currently happening; it is not complicated by either the past behaviour or future intentions or attitudes. Thirdly, this method is independent of respondents' willingness to respond and as such is relatively less demanding of active cooperation on the part of respondents as happens to be the case in the interview or the questionnaire method. This method is particularly suitable in studies which deal with subjects (i.e., respondents) who are not capable of giving verbal reports of their feelings for one reason or the other

However, observation method has various limitations. Firstly, it is an expensive method. Secondly, the information provided by this method is very limited. Thirdly, sometimes unforeseen factors may interfere with the observational task. At times, the fact that some people are rarely accessible to direct observation creates obstacle for this method to collect data effectively.

While using this method, the researcher should keep in mind things like: What should be observed? How the observations should be recorded? Or how the accuracy of observation can be ensured? In case the observation is characterised by a careful definition of the units to be observed, the style of recording the observed information, standardised conditions of observation and the selection of pertinent data of observation, then the observation is called as *structured observation.* But when observation is to take place without these characteristics to be thought of in advance, the same is termed *as unstructured observation.* Structured observation is considered appropriate in descriptive studies, whereas in an exploratory study the observational procedure is most likely to be relatively unstructured.

We often talk about participant and non-participant types of observation in the context of studies, particularly of social sciences. This distinction depends upon the observer's sharing or not sharing the life of the group he is observing. If the observer observes by making himself, more or less, a member of the group he is observing so that he can experience what the members of the group experience, the observation is called as the *participant observation.* But when the observer observes as a detached emissary without any attempt on his part to experience through participation what others feel, the observation of this type is often termed as *non-participant observation.* (When the observer is observing in such a manner that his presence may be unknown to the people he is observing, such an observation is described as *disguised observation.*)

There are several merits of the participant type of observation: (i) The researcher is enabled to record the natural behaviour of the group. (ii) The researcher can even gather information which could not easily be obtained if he observes in a disinterested fashion. (iii) The researcher can even verify the truth of statements made by informants in the context of a questionnaire or a schedule. But there are also certain demerits of this type of observation viz., the observer may lose the objectivity to the extent he participates emotionally; the problem of observation-control is not solved; and it may narrow-down the researcher's range of experience.

Sometimes we talk of *controlled* and *uncontrolled observation.* If the observation takes place in the natural setting, it may be termed as uncontrolled observation, but when observation takes place according to definite pre-arranged plans, involving experimental procedure, the same is then termed controlled observation. In non-controlled observation, no attempt is made to use precision instruments. The major aim of this type of observation is to get a spontaneous picture of life and persons. It has a tendency to supply naturalness and completeness of behaviour, allowing sufficient time for observing it. But in controlled observation, we use mechanical (or precision) instruments as aids to accuracy and standardisation. Such observation has a tendency to supply formalised data upon which generalisations can be built with some degree of assurance. The main pitfall of non-controlled observation is that of subjective interpretation. There is also the danger of having the feeling that we know more about the observed phenomena than we actually do. Generally, controlled observation takes place in various experiments that are carried out in a laboratory or under controlled conditions, whereas uncontrolled observation is resorted to in case of exploratory researches.

Interview Method

The interview method of collecting data involves presentation of oral-verbal stimuli and reply in terms of oral-verbal responses. This method can be used through personal interviews and, if possible, through telephone interviews.

(a) *Personal interviews:* Personal interview method requires a person known as the interviewer asking questions generally in a face-to-face contact to the other person or persons. (At times the interviewee may also ask certain questions and the interviewer responds to these, but usually the interviewer initiates the interview and collects the information.) This sort of interview may be in the form of direct personal investigation or it may be indirect oral investigation. In the case of direct personal investigation the interviewer has to collect the information personally from the sources concerned. He has to be on the spot and has to meet people from whom data have to be collected. This method is particularly suitable for intensive investigations. But in certain cases it may not be possible or worthwhile to contact directly the persons concerned or on account of the extensive scope of enquiry, the direct personal investigation technique may not be used. In such cases an indirect oral examination can be conducted under which the interviewer has to cross-examine other persons who are supposed to have knowledge about the problem under investigation and the information, obtained is recorded. Most of the commissions and committees appointed by government to carry on investigations make use of this method.

The method of collecting information through personal interviews is usually carried out in a structured way. As such we call the interviews as *structured interviews.* Such interviews involve the use of a set of predetermined questions and of highly standardised techniques of recording. Thus,

the interviewer in a structured interview follows a rigid procedure laid down, asking questions in a form and order prescribed. As against it, the *unstructured interviews* are characterised by a flexibility of approach to questioning. Unstructured interviews do not follow a system of pre-determined questions and standardised techniques of recording information. In a non-structured interview, the interviewer is allowed much greater freedom to ask, in case of need, supplementary questions or at times he may omit certain questions if the situation so requires. He may even change the sequence of questions. He has relatively greater freedom while recording the responses to include some aspects and exclude others. But this sort of flexibility results in lack of comparability of one interview with another and the analysis of unstructured responses becomes much more difficult and time-consuming than that of the structured responses obtained in case of structured interviews. Unstructured interviews also demand deep knowledge and greater skill on the part of the interviewer. Unstructured interview, however, happens to be the central technique of collecting information in case of exploratory or formulative research studies. But in case of descriptive studies, we quite often use the technique of structured interview because of its being more economical, providing a safe basis for generalisation and requiring relatively lesser skill on the part of the interviewer.

We may as well talk about focussed interview, clinical interview and the non-directive interview. *Focussed interview* is meant to focus attention on the given experience of the respondent and its effects. Under it the interviewer has the freedom to decide the manner and sequence in which the questions would be asked and has also the freedom to explore reasons and motives. The main task of the interviewer in case of a focussed interview is to confine the respondent to a discussion of issues with which he seeks conversance. Such interviews are used generally in the development of hypotheses and constitute a major type of unstructured interviews. The *clinical interview* is concerned with broad underlying feelings or motivations or with the course of individual's life experience. The method of eliciting information under it is generally left to the interviewer's discretion. In case of *non-directive interview*, the interviewer's function is simply to encourage the respondent to talk about the given topic with a bare minimum of direct questioning. The interviewer often acts as a catalyst to a comprehensive expression of the respondents' feelings and beliefs and of the frame of reference within which such feelings and beliefs take on personal significance.

Despite the variations in interview-techniques, the major advantages and weaknesses of personal interviews can be enumerated in a general way. The chief merits of the interview method are as follows:

(i) More information and that too in greater depth can be obtained.

(ii) Interviewer by his own skill can overcome the resistance, if any, of the respondents; the interview method can be made to yield an almost perfect sample of the general population.

(iii) There is greater flexibility under this method as the opportunity to restructure questions is always there, specially in case of unstructured interviews.

(iv) Observation method can as well be applied to recording verbal answers to various questions.

(v) Personal information can as well be obtained easily under this method.

(vi) Samples can be controlled more effectively as there arises no difficulty of the missing returns; non-response generally remains very low.

(vii) The interviewer can usually control which person(s) will answer the questions. This is not possible in mailed questionnaire approach. If so desired, group discussions may also be held.

(viii) The interviewer may catch the informant off-guard and thus may secure the most spontaneous reactions than would be the case if mailed questionnaire is used.

(ix) The language of the interview can be adopted to the ability or educational level of the person interviewed and as such misinterpretations concerning questions can be avoided.

(x) The interviewer can collect supplementary information about the respondent's personal characteristics and environment which is often of great value in interpreting results.

But there are also certain weaknesses of the interview method. Among the important weaknesses, mention may be made of the following:

(i) It is a very expensive method, specially when large and widely spread geographical sample is taken.

(ii) There remains the possibility of the bias of interviewer as well as that of the respondent; there also remains the headache of supervision and control of interviewers.

(iii) Certain types of respondents such as important officials or executives or people in high income groups may not be easily approachable under this method and to that extent the data may prove inadequate.

(iv) This method is relatively more-time-consuming, specially when the sample is large and re-calls upon the respondents are necessary.

(v) The presence of the interviewer on the spot may over-stimulate the respondent, sometimes even to the extent that he may give imaginary information just to make the interview interesting.

(vi) Under the interview method the organisation required for selecting, training and supervising the field-staff is more complex with formidable problems.

(vii) Interviewing at times may also introduce systematic errors.

(viii) Effective interview presupposes proper rapport with respondents that would facilitate free and frank responses. This is often a very difficult requirement.

Pre-requisites and basic tenets of interviewing: For successful implementation of the interview method, interviewers should be carefully selected, trained and briefed. They should be honest, sincere, hardworking, impartial and must possess the technical competence and necessary practical experience. Occasional field checks should be made to ensure that interviewers are neither cheating, nor deviating from instructions given to them for performing their job efficiently. In addition, some provision should also be made in advance so that appropriate action may be taken if some of the selected respondents refuse to cooperate or are not available when an interviewer calls upon them.

In fact, interviewing is an art governed by certain scientific principles. Every effort should be made to create friendly atmosphere of trust and confidence, so that respondents may feel at ease while talking to and discussing with the interviewer. The interviewer must ask questions properly and intelligently and must record the responses accurately and completely. At the same time, the interviewer must answer legitimate question(s), if any, asked by the respondent and must clear any doubt that the latter has. The interviewers approach must be friendly, courteous, conversational and unbiased. The interviewer should not show surprise or disapproval of a respondent's answer but he must keep the direction of interview in his own hand, discouraging irrelevant conversation and must make all possible effort to keep the respondent on the track.

(b) *Telephone interviews:* This method of collecting information consists in contacting respondents on telephone itself. It is not a very widely used method, but plays important part in industrial surveys, particularly in developed regions. The chief merits of such a system are:

1. It is more flexible in comparison to mailing method.
2. It is faster than other methods i.e., a quick way of obtaining information.
3. It is cheaper than personal interviewing method; here the cost per response is relatively low.
4. Recall is easy; callbacks are simple and economical.
5. There is a higher rate of response than what we have in mailing method; the non-response is generally very low.
6. Replies can be recorded without causing embarrassment to respondents.
7. Interviewer can explain requirements more easily.
8. At times, access can be gained to respondents who otherwise cannot be contacted for one reason or the other.
9. No field staff is required.
10. Representative and wider distribution of sample is possible.

But this system of collecting information is not free from demerits. Some of these may be highlighted.

1. Little time is given to respondents for considered answers; interview period is not likely to exceed five minutes in most cases.
2. Surveys are restricted to respondents who have telephone facilities.
3. Extensive geographical coverage may get restricted by cost considerations.
4. It is not suitable for intensive surveys where comprehensive answers are required to various questions.
5. Possibility of the bias of the interviewer is relatively more.
6. Questions have to be short and to the point; probes are difficult to handle.

COLLECTION OF DATA THROUGH QUESTIONNAIRES

This method of data collection is quite popular, particularly in case of big enquiries. It is being adopted by private individuals, research workers, private and public organisations and even by governments. In this method a questionnaire is sent (usually by post) to the persons concerned with a request to answer the questions and return the questionnaire. A questionnaire consists of a number of questions printed or typed in a definite order on a form or set of forms. The questionnaire is mailed to respondents who are expected to read and understand the questions and write down the reply in the space meant for the purpose in the questionnaire itself. The respondents have to answer the questions on their own.

The method of collecting data by mailing the questionnaires to respondents is most extensively employed in various economic and business surveys. The merits claimed on behalf of this method are as follows:

1. There is low cost even when the universe is large and is widely spread geographically.

2. It is free from the bias of the interviewer; answers are in respondents' own words.
3. Respondents have adequate time to give well thought out answers.
4. Respondents, who are not easily approachable, can also be reached conveniently.
5 Large samples can be made use of and thus the results can be made more dependable and reliable.

The main demerits of this system can also be listed here:

1. Low rate of return of the duly filled in questionnaires; bias due to no-response is often indeterminate.
2. It can be used only when respondents are educated and cooperating.
3. The control over questionnaire may be lost once it is sent.
4. There is inbuilt inflexibility because of the difficulty of amending the approach once questionnaires have been despatched.
5. There is also the possibility of ambiguous replies or omission of replies altogether to certain questions; interpretation of omissions is difficult.
6. It is difficult to know whether willing respondents are truly representative.
7. This method is likely to be the slowest of all.

Before using this method, it is always advisable to conduct 'pilot study' (Pilot Survey) for testing the questionnaires. In a big enquiry the significance of pilot survey is felt very much. Pilot survey is infact the replica and rehearsal of the main survey. Such a survey, being conducted by experts, brings to the light the weaknesses (if any) of the questionnaires and also of the survey techniques. From the experience gained in this way, improvement can be effected.

Main aspects of a questionnaire: Quite often questionnaire is considered as the heart of a survey operation. Hence it should be very carefully constructed. If it is not properly set up, then the survey is bound to fail. This fact requires us to study the main aspects of a questionnaire viz., the general form, question sequence and question formulation and wording. Researcher should note the following with regard to these three main aspects of a questionnaire:

1. *General form:* So far as the general form of a questionnaire is concerned, it can either be structured or unstructured questionnaire. Structured questionnaires are those questionnaires in which there are definite, concrete and pre-determined questions. The questions are presented with exactly the same wording and in the same order to all respondents. Resort is taken to this sort of standardisation to ensure that all respondents reply to the same set of questions. The form of the question may be either closed (i.e., of the type 'yes' or 'no') or open (i.e., inviting free response) but should be stated in advance and not constructed during questioning. Structured questionnaires may also have fixed alternative questions in which responses of the informants are limited to the stated alternatives. Thus a highly structured questionnaire is one in which all questions and answers are specified and comments in the respondent's own words are held to the minimum. When these characteristics are not present in a questionnaire, it can be termed as unstructured or non-structured questionnaire. More specifically, we can say that in an unstructured questionnaire, the interviewer is provided with a general guide on the type of information to be obtained, but the exact question formulation is largely his own responsibility and the replies are to be taken down in the respondent's own words to the extent possible; in some situations tape recorders may be used to achieve this goal.

Structured questionnaires are simple to administer and relatively inexpensive to analyse. The provision of alternative replies, at times, helps to understand the meaning of the question clearly. But such questionnaires have limitations too. For instance, wide range of data and that too in respondent's own words cannot be obtained with structured questionnaires. They are usually considered inappropriate in investigations where the aim happens to be to probe for attitudes and reasons for certain actions or feelings. They are equally not suitable when a problem is being first explored and working hypotheses sought. In such situations, unstructured questionnaires may be used effectively. Then on the basis of the results obtained in pretest (testing before final use) operations from the use of unstructured questionnaires, one can construct a structured questionnaire for use in the main study.

2. *Question sequence:* In order to make the questionnaire effective and to ensure quality to the replies received, a researcher should pay attention to the question-sequence in preparing the questionnaire. A proper sequence of questions reduces considerably the chances of individual questions being misunderstood. The question-sequence must be clear and smoothly-moving, meaning thereby that the relation of one question to another should be readily apparent to the respondent, with questions that are easiest to answer being put in the beginning. The first few questions are particularly important because they are likely to influence the attitude of the respondent and in seeking his desired cooperation. The opening questions should be such as to arouse human interest. The following type of questions should generally be avoided as opening questions in a questionnaire:

1. questions that put too great a strain on the memory or intellect of the respondent;
2. questions of a personal character;
3. questions related to personal wealth, etc.

Following the opening questions, we should have questions that are really vital to the research problem and a connecting thread should run through successive questions. Ideally, the question-sequence should conform to the respondent's way of thinking. Knowing what information is desired, the researcher can rearrange the order of the questions (this is possible in case of unstructured questionnaire) to fit the discussion in each particular case. But in a structured questionnaire the best that can be done is to determine the question-sequence with the help of a Pilot Survey which is likely to produce good rapport with most respondents. Relatively difficult questions must be relegated towards the end so that even if the respondent decides not to answer such questions, considerable information would have already been obtained. Thus, question-sequence should usually go from the general to the more specific and the researcher must always remember that the answer to a given question is a function not only of the question itself, but of all previous questions as well. For instance, if one question deals with the price usually paid for coffee and the next with reason for preferring that particular brand, the answer to this latter question may be couched largely in terms of price-differences.

3. *Question formulation and wording:* With regard to this aspect of questionnaire, the researcher should note that each question must be very clear for any sort of misunderstanding can do irreparable harm to a survey. Question should also be impartial in order not to give a biased picture of the true state of affairs. Questions should be constructed with a view to their forming a logical part of a well thought out tabulation plan. In general, all questions should meet the following standards—(a) should be easily understood; (b) should be simple i.e., should convey only one thought at a time; (c) should be concrete and should conform as much as possible to the respondent's way of thinking. (For

instance, instead of asking. "How many razor blades do you use annually?" The more realistic question would be to ask, "How many razor blades did you use last week?"

Concerning the form of questions, we can talk about two principal forms, viz., multiple choice question and the open-end question. In the former the respondent selects one of the alternative possible answers put to him, whereas in the latter he has to supply the answer in his own words. The question with only two possible answers (usually 'Yes' or 'No') can be taken as a special case of the multiple choice question, or can be named as a 'closed question.' There are some advantages and disadvantages of each possible form of question. Multiple choice or closed questions have the advantages of easy handling, simple to answer, quick and relatively inexpensive to analyse. They are most amenable to statistical analysis. Sometimes, the provision of alternative replies helps to make clear the meaning of the question. But the main drawback of fixed alternative questions is that of "putting answers in people's mouths" i.e., they may force a statement of opinion on an issue about which the respondent does not infact have any opinion. They are not appropriate when the issue under consideration happens to be a complex one and also when the interest of the researcher is in the exploration of a process. In such situations, open-ended questions which are designed to permit a free response from the respondent rather than one limited to certain stated alternatives are considered appropriate. Such questions give the respondent considerable latitude in phrasing a reply. Getting the replies in respondent's own words is, thus, the major advantage of open-ended questions. But one should not forget that, from an analytical point of view, open-ended questions are more difficult to handle, raising problems of interpretation, comparability and interviewer bias.*

In practice, one rarely comes across a case when one questionnaire relies on one form of questions alone. The various forms complement each other. As such questions of different forms are included in one single questionnaire. For instance, multiple-choice questions constitute the basis of a structured questionnaire, particularly in a mail survey. But even there, various open-ended questions are generally inserted to provide a more complete picture of the respondent's feelings and attitudes.

Researcher must pay proper attention to the wordings of questions since reliable and meaningful returns depend on it to a large extent. Since words are likely to affect responses, they should be properly chosen. Simple words, which are familiar to all respondents should be employed. Words with ambiguous meanings must be avoided. Similarly, danger words, catch-words or words with emotional connotations should be avoided. Caution must also be exercised in the use of phrases which reflect upon the prestige of the respondent. Question wording, in no case, should bias the answer. In fact, question wording and formulation is an art and can only be learnt by practice.

Essentials of a good questionnaire: To be successful, questionnaire should be comparatively short and simple i.e., the size of the questionnaire should be kept to the minimum. Questions should proceed in logical sequence moving from easy to more difficult questions. Personal and intimate questions should be left to the end. Technical terms and vague expressions capable of different interpretations should be avoided in a questionnaire. Questions may be dichotomous (yes or no answers), multiple choice (alternative answers listed) or open-ended. The latter type of questions are often difficult to analyse and hence should be avoided in a questionnaire to the extent possible. There should be some control questions in the questionnaire which indicate the reliability of the respondent. For instance, a question designed to determine the consumption of particular material may be asked

* Interviewer bias refers to the extent to which an answer is altered in meaning by some action or attitude on the part of the interviewer.

first in terms of financial expenditure and later in terms of weight. The control questions, thus, introduce a cross-check to see whether the information collected is correct or not. Questions affecting the sentiments of respondents should be avoided. Adequate space for answers should be provided in the questionnaire to help editing and tabulation. There should always be provision for indications of uncertainty, e.g., "do not know," "no preference" and so on. Brief directions with regard to filling up the questionnaire should invariably be given in the questionnaire itself. Finally, the physical appearance of the questionnaire affects the cooperation the researcher receives from the recipients and as such an attractive looking questionnaire, particularly in mail surveys, is a plus point for enlisting cooperation. The quality of the paper, along with its colour, must be good so that it may attract the attention of recipients.

COLLECTION OF DATA THROUGH SCHEDULES

This method of data collection is very much like the collection of data through questionnaire, with little difference which lies in the fact that schedules (proforma containing a set of questions) are being filled in by the enumerators who are specially appointed for the purpose. These enumerators along with schedules, go to respondents, put to them the questions from the proforma in the order the questions are listed and record the replies in the space meant for the same in the proforma. In certain situations, schedules may be handed over to respondents and enumerators may help them in recording their answers to various questions in the said schedules. Enumerators explain the aims and objects of the investigation and also remove the difficulties which any respondent may feel in understanding the implications of a particular question or the definition or concept of difficult terms.

This method requires the selection of enumerators for filling up schedules or assisting respondents to fill up schedules and as such enumerators should be very carefully selected. The enumerators should be trained to perform their job well and the nature and scope of the investigation should be explained to them thoroughly so that they may well understand the implications of different questions put in the schedule. Enumerators should be intelligent and must possess the capacity of cross-examination in order to find out the truth. Above all, they should be honest, sincere, hardworking and should have patience and perseverance.

This method of data collection is very useful in extensive enquiries and can lead to fairly reliable results. It is, however, very expensive and is usually adopted in investigations conducted by governmental agencies or by some big organisations. Population census all over the world is conducted through this method.

DIFFERENCE BETWEEN QUESTIONNAIRES AND SCHEDULES

Both questionnaire and schedule are popularly used methods of collecting data in research surveys. There is much resemblance in the nature of these two methods and this fact has made many people to remark that from a practical point of view, the two methods can be taken to be the same. But from the technical point of view there is difference between the two. The important points of difference are as under:

1. The questionnaire is generally sent through mail to informants to be answered as specified in a covering letter, but otherwise without further assistance from the sender. The schedule

is generally filled out by the research worker or the enumerator, who can interpret questions when necessary.

2. To collect data through questionnaire is relatively cheap and economical since we have to spend money only in preparing the questionnaire and in mailing the same to respondents. Here no field staff required. To collect data through schedules is relatively more expensive since considerable amount of money has to be spent in appointing enumerators and in importing training to them. Money is also spent in preparing schedules.
3. Non-response is usually high in case of questionnaire as many people do not respond and many return the questionnaire without answering all questions. Bias due to non-response often remains indeterminate. As against this, non-response is generally very low in case of schedules because these are filled by enumerators who are able to get answers to all questions. But there remains the danger of interviewer bias and cheating.
4. In case of questionnaire, it is not always clear as to who replies, but in case of schedule the identity of respondent is known.
5. The questionnaire method is likely to be very slow since many respondents do not return the questionnaire in time despite several reminders, but in case of schedules the information is collected well in time as they are filled in by enumerators.
6. Personal contact is generally not possible in case of the questionnaire method as questionnaires are sent to respondents by post who also in turn return the same by post. But in case of schedules direct personal contact is established with respondents.
7. Questionnaire method can be used only when respondents are literate and cooperative, but in case of schedules the information can be gathered even when the respondents happen to be illiterate.
8. Wider and more representative distribution of sample is possible under the questionnaire method, but in respect of schedules there usually remains the difficulty in sending enumerators over a relatively wider area.
9. Risk of collecting incomplete and wrong information is relatively more under the questionnaire method, particularly when people are unable to understand questions properly. But in case of schedules, the information collected is generally complete and accurate as enumerators can remove the difficulties, if any, faced by respondents in correctly understanding the questions. As a result, the information collected through schedules is relatively more accurate than that obtained through questionnaires.
10. The success of questionnaire method lies more on the quality of the questionnaire itself, but in the case of schedules much depends upon the honesty and competence of enumerators.
11. In order to attract the attention of respondents, the physical appearance of questionnaire must be quite attractive, but this may not be so in case of schedules as they are to be filled in by enumerators and not by respondents.
12. Along with schedules, observation method can also be used but such a thing is not possible while collecting data through questionnaires.

SOME OTHER METHODS OF DATA COLLECTION

Let us consider some other methods of data collection, particularly used by big business houses in modern times.

1. Warranty cards: Warranty cards are usually postal sized cards which are used by dealers of consumer durables to collect information regarding their products. The information sought is printed in the form of questions on the 'warranty cards' which is placed inside the package along with the product with a request to the consumer to fill in the card and post it back to the dealer.

2. Distributor or store audits: Distributor or store audits are performed by distributors as well as manufactures through their salesmen at regular intervals. Distributors get the retail stores audited through salesmen and use such information to estimate market size, market share, seasonal purchasing pattern and so on. The data are obtained in such audits not by questioning but by observation. For instance, in case of a grocery store audit, a sample of stores is visited periodically and data are recorded on inventories on hand either by observation or copying from store records. Store audits are invariably panel operations, for the derivation of sales estimates and compilation of sales trends by stores are their principal '*raison detre*'. The principal advantage of this method is that it offers the most efficient way of evaluating the effect on sales of variations of different techniques of in-store promotion.

3. Pantry audits: Pantry audit technique is used to estimate consumption of the basket of goods at the consumer level. In this type of audit, the investigator collects an inventory of types, quantities and prices of commodities consumed. Thus in pantry audit data are recorded from the examination of consumer's pantry. The usual objective in a pantry audit is to find out what types of consumers buy certain products and certain brands, the assumption being that the contents of the pantry accurately portray consumer's preferences. Quite often, pantry audits are supplemented by direct questioning relating to reasons and circumstances under which particular products were purchased in an attempt to relate these factors to purchasing habits. A pantry audit may or may not be set up as a panel operation, since a single visit is often considered sufficient to yield an accurate picture of consumers' preferences. An important limitation of pantry audit approach is that, at times, it may not be possible to identify consumers' preferences from the audit data alone, particularly when promotion devices produce a marked rise in sales.

4. Consumer panels: An extension of the pantry audit approach on a regular basis is known as 'consumer panel', where a set of consumers are arranged to come to an understanding to maintain detailed daily records of their consumption and the same is made available to investigator on demands. In other words, a consumer panel is essentially a sample of consumers who are interviewed repeatedly over a period of time. Mostly consume panels are of two types viz., the transitory consumer panel and the continuing consumer panel. *A transitory consumer panel* is set up to measure the effect of a particular phenomenon. Usually such a panel is conducted on a before-and-after-basis. Initial interviews are conducted before the phenomenon takes place to record the attitude of the consumer. A second set of interviews is carried out after the phenomenon has taken place to find out the consequent changes that might have occurred in the consumer's attitude. It is a favourite tool of advertising and of social research. A *continuing consumer panel* is often set up for an indefinite period with a view to collect data on a particular aspect of consumer behaviour over time, generally at periodic intervals or may be meant to serve as a general purpose panel for researchers on a variety of subjects. Such panels have been used in the area of consumer expenditure, public opinion and radio and TV listenership

among others. Most of these panels operate by mail. The representativeness of the panel relative to the population and the effect of panel membership on the information obtained after the two major problems associated with the use of this method of data collection.

5. Use of mechanical devices: The use of mechanical devices has been widely made to collect information by way of indirect means. Eye camera, Pupilometric camera, Psychogalvanometer, Motion picture camera and Audiometer are the principal devices so far developed and commonly used by modern big business houses, mostly in the developed world for the purpose of collecting the required information.

Eye cameras are designed to record the focus of eyes of a respondent on a specific portion of a sketch or diagram or written material. Such an information is useful in designing advertising material. Pupilometric cameras record dilation of the pupil as a result of a visual stimulus. The extent of dilation shows the degree of interest aroused by the stimulus. Psychogalvanometer is used for measuring the extent of body excitement as a result of the visual stimulus. Motion picture cameras can be used to record movement of body of a buyer while deciding to buy a consumer good from a shop or big store. Influence of packaging or the information given on the label would stimulate a buyer to perform certain physical movements which can easily be recorded by a hidden motion picture camera in the shop's four walls. Audiometers are used by some TV concerns to find out the type of programmes as well as stations preferred by people. A device is fitted in the television instrument itself to record these changes. Such data may be used to find out the market share of competing television stations.

6. Projective techniques: Projective techniques (or what are sometimes called as indirect interviewing techniques) for the collection of data have been developed by psychologists to use projections of respondents for inferring about underlying motives, urges, or intentions which are such that the respondent either resists to reveal them or is unable to figure out himself. In projective techniques the respondent in supplying information tends unconsciously to project his own attitudes or feelings on the subject under study. Projective techniques play an important role in motivational researches or in attitude surveys.

The use of these techniques requires intensive specialised training. In such techniques, the individual's responses to the stimulus-situation are not taken at their face value. The stimuli may arouse many different kinds of reactions. The nature of the stimuli and the way in which they are presented under these techniques do not clearly indicate the way in which the response is to be interpreted. The stimulus may be a photograph, a picture, an inkblot and so on. Responses to these stimuli are interpreted as indicating the individual's own view, his personality structure, his needs, tensions, etc. in the context of some pre-established psychological conceptualisation of what the individual's responses to the stimulus mean.

We may now briefly deal with the important projective techniques.

(i) *Word association tests:* These tests are used to extract information regarding such words which have maximum association. In this sort of test the respondent is asked to mention the first word that comes to mind, ostensibly without thinking, as the interviewer reads out each word from a list. If the interviewer says *cold*, the respondent may say *hot* and the like ones. The general technique is to use a list of as many as 50 to 100 words. Analysis of the matching words supplied by the respondents indicates whether the given word should be used for the contemplated purpose. The same idea is exploited in marketing research to find out the quality that is mostly associated to a brand of a product. A number of qualities of a product may be listed and informants may be asked to write

brand names possessing one or more of these. This technique is quick and easy to use, but yields reliable results when applied to words that are widely known and which possess essentially one type of meaning. This technique is frequently used in advertising research.

(ii) *Sentence completion tests:* These tests happen to be an extension of the technique of word association tests. Under this, informant may be asked to complete a sentence (such as: persons who wear Khadi are...) to find association of Khadi clothes with certain personality characteristics. Several sentences of this type might be put to the informant on the same subject. Analysis of replies from the same informant reveals his attitude toward that subject, and the combination of these attitudes of all the sample members is then taken to reflect the views of the population. This technique permits the testing not only of words (as in case of word association tests), but of ideas as well and thus, helps in developing hypotheses and in the construction of questionnaires. This technique is also quick and easy to use, but it often leads to analytical problems, particularly when the response happens to be multidimensional.

(iii) *Story completion tests:* Such tests are a step further wherein the researcher may contrive stories instead of sentences and ask the informants to complete them. The respondent is given just enough of story to focus his attention on a given subject and he is asked to supply a conclusion to the story.

(iv) *Verbal projection tests:* These are the tests wherein the respondent is asked to comment on or to explain what other people do. For example, why do people smoke? Answers may reveal the respondent's own motivations.

(v) *Pictorial techniques:* There are several pictorial techniques. The important ones are as follows:

(a) *Thematic apperception test (T.A.T.):* The TAT consists of a set of pictures (some of the pictures deal with the ordinary day-to-day events while others may be ambiguous pictures of unusual situations) that are shown to respondents who are asked to describe what they think the pictures represent. The replies of respondents constitute the basis for the investigator to draw inferences about their personality structure, attitudes, etc.

(b) *Rosenzweig test:* This test uses a cartoon format wherein we have a series of cartoons with words inserted in 'balloons' above. The respondent is asked to put his own words in an empty balloon space provided for the purpose in the picture. From what the respondents write in this fashion, the study of their attitudes can be made.

(c) *Rorschach test:* This test consists of ten cards having prints of inkblots. The design happens to be symmetrical but meaningless. The respondents are asked to describe what they perceive in such symmetrical inkblots and the responses are interpreted on the basis of some pre-determined psychological framework. This test is frequently used but the problem of validity still remains a major problem of this test.

(d) *Holtzman Inkblot Test (HIT):* This test from W.H. Holtzman is a modification of the Rorschach Test explained above. This test consists of 45 inkblot cards (and not 10 inkblots as we find in case of Rorschach Test) which are based on colour, movement, shading and other factors involved in inkblot perception. Only one response per card is obtained from the subject (or the respondent) and the responses of a subject are interpreted at three levels of form appropriateness. Form responses are interpreted for knowing the accuracy (F) or inaccuracy (F–) of respondent's percepts; shading and colour for ascertaining his affectional and emotional needs; and movement responses for assessing the dynamic aspects of his life.

Holtzman Inkblot Test or H.I.T. has several special features or advantages. For example, it elicits relatively constant number of responses per respondent. Secondly, it facilitates studying the responses of a respondent to different cards in the light of norms of each card instead of lumping them together. Thirdly, it elicits much more information from the respondent then is possible with merely 10 cards in Rorschach test; the 45 cards used in this test provide a variety of stimuli to the respondent and as such the range of responses elicited by the test is comparatively wider.

There are some limitations of this test as well. One difficulty that remains in using this test is that most of the respondents do not know the determinants of their perceptions, but for the researcher, who has to interpret the protocols of a subject and understand his personality (or attitude) through them, knowing the determinant of each of his response is a must. This fact emphasises that the test must be administered individually and a post-test inquiry must as well be conducted for knowing the nature and sources of responses and this limits the scope of HIT as a group test of personality. Not only this, "the usefulness of HIT for purposes of personal selection, vocational guidance, etc. is still to be established."[1]

In view of these limitations, some people have made certain changes in applying this test. For instance, Fisher and Cleveland in their approach for obtaining Barrier score of an individual's personality have developed a series of multiple choice items for 40 of HIT cards. Each of these cards is presented to the subject along with three acceptable choices [such as 'Knight in armour' (Barrier response), 'X-Ray' (Penetrating response) and 'Flower' (Neutral response)]. Subject taking the test is to check the choice he likes most, make a different mark against the one he likes least and leave the third choice blank. The number of barrier responses checked by him determines his barrier score on the test.

(e) *Tomkins-Horn picture arrangement test:* This test is designed for group administration. It consists of twenty-five plates, each containing three sketches that may be arranged in different ways to portray sequence of events. The respondent is asked to arrange them in a sequence which he considers as reasonable. The responses are interpreted as providing evidence confirming certain norms, respondent's attitudes, etc.

(vi) *Play techniques:* Under play techniques subjects are asked to improvise or act out a situation in which they have been assigned various roles. The researcher may observe such traits as hostility, dominance, sympathy, prejudice or the absence of such traits. These techniques have been used for knowing the attitudes of younger ones through manipulation of dolls. Dolls representing different racial groups are usually given to children who are allowed to play with them freely. The manner in which children organise dolls would indicate their attitude towards the class of persons represented by dolls. This is also known as *doll-play test*, and is used frequently in studies pertaining to sociology. The choice of colour, form, words, the sense of orderliness and other reactions may provide opportunities to infer deep-seated feelings.

(vii) *Quizzes, tests and examinations:* This is also a technique of extracting information regarding specific ability of candidates indirectly. In this procedure both long and short questions are framed to test through them the memorising and analytical ability of candidates.

(viii) *Sociometry:* Sociometry is a technique for describing the social relationships among individuals in a group. In an indirect way, sociometry attempts to describe attractions or repulsions between

[1] S.L. Dass, "*Personality Assessment Through Projective Movie Pictures*", p. 17.

individuals by asking them to indicate whom they would choose or reject in various situations. Thus, sociometry is a new technique of studying the underlying motives of respondents. "Under this an attempt is made to trace the flow of information amongst groups and then examine the ways in which new ideas are diffused. Sociograms are constructed to identify leaders and followers."[2] Sociograms are charts that depict the sociometric choices. There are many versions of the sociogram pattern and the reader is suggested to consult specialised references on sociometry for the purpose. This approach has been applied to the diffusion of ideas on drugs amongst medical practitioners.

7. Depth interviews: Depth interviews are those interviews that are designed to discover underlying motives and desires and are often used in motivational research. Such interviews are held to explore needs, desires and feelings of respondents. In other words, they aim to elicit unconscious as also other types of material relating especially to personality dynamics and motivations. As such, depth interviews require great skill on the part of the interviewer and at the same time involve considerable time. Unless the researcher has specialised training, depth interviewing should not be attempted.

Depth interview may be projective in nature or it may be a non-projective interview. The difference lies in the nature of the questions asked. Indirect questions on seemingly irrelevant subjects provide information that can be related to the informant's behaviour or attitude towards the subject under study. Thus, for instance, the informant may be asked on his frequency of air travel and he might again be asked at a later stage to narrate his opinion concerning the feelings of relatives of some other man who gets killed in an airplane accident. Reluctance to fly can then be related to replies to questions of the latter nature. If the depth interview involves questions of such type, the same may be treated as projective depth interview. But in order to be useful, depth interviews do not necessarily have to be projective in nature; even non-projective depth interviews can reveal important aspects of psycho-social situation for understanding the attitudes of people.

8. Content-analysis: Content-analysis consists of analysing the contents of documentary materials such as books, magazines, newspapers and the contents of all other verbal materials which can be either spoken or printed. Content-analysis prior to 1940's was mostly quantitative analysis of documentary materials concerning certain characteristics that can be identified and counted. But since 1950's content-analysis is mostly qualitative analysis concerning the general import or message of the existing documents. "The difference is somewhat like that between a casual interview and depth interviewing."[3] Bernard Berelson's name is often associated with. the latter type of content-analysis. "Content-analysis is measurement through proportion…. Content analysis measures pervasiveness and that is sometimes an index of the intensity of the force."[4]

The analysis of content is a central activity whenever one is concerned with the study of the nature of the verbal materials. A review of research in any area, for instance, involves the analysis of the contents of research articles that have been published. The analysis may be at a relatively simple level or may be a subtle one. It is at a simple level when we pursue it on the basis of certain characteristics of the document or verbal materials that can be identified and counted (such as on the basis of major scientific concepts in a book). It is at a subtle level when researcher makes a study of the attitude, say of the press towards education by feature writers.

[2] G.B. Giles, *Marketing,* p. 40–41.

[3] Carter V. Good and Douglas E. Scates, *Methods of Research,* p. 670.

[4] *Ibid.,* p. 670.

COLLECTION OF SECONDARY DATA

Secondary data means data that are already available i.e., they refer to the data which have already been collected and analysed by someone else. When the researcher utilises secondary data, then he has to look into various sources from where he can obtain them. In this case he is certainly not confronted with the problems that are usually associated with the collection of original data. Secondary data may either be published data or unpublished data. Usually published data are available in: (a) various publications of the central, state are local governments; (b) various publications of foreign governments or of international bodies and their subsidiary organisations; (c) technical and trade journals; (d) books, magazines and newspapers; (e) reports and publications of various associations connected with business and industry, banks, stock exchanges, etc.; (f) reports prepared by research scholars, universities, economists, etc. in different fields; and (g) public records and statistics, historical documents, and other sources of published information. The sources of unpublished data are many; they may be found in diaries, letters, unpublished biographies and autobiographies and also may be available with scholars and research workers, trade associations, labour bureaus and other public/ private individuals and organisations.

Researcher must be very careful in using secondary data. He must make a minute scrutiny because it is just possible that the secondary data may be unsuitable or may be inadequate in the context of the problem which the researcher wants to study. In this connection Dr. A.L. Bowley very aptly observes that it is never safe to take published statistics at their face value without knowing their meaning and limitations and it is always necessary to criticise arguments that can be based on them.

By way of caution, the researcher, before using secondary data, must see that they possess following characteristics:

1. Reliability of data: The reliability can be tested by finding out such things about the said data: (a) Who collected the data? (b) What were the sources of data? (c) Were they collected by using proper methods (d) At what time were they collected?(e) Was there any bias of the compiler? (t) What level of accuracy was desired? Was it achieved ?

2. Suitability of data: The data that are suitable for one enquiry may not necessarily be found suitable in another enquiry. Hence, if the available data are found to be unsuitable, they should not be used by the researcher. In this context, the researcher must very carefully scrutinise the definition of various terms and units of collection used at the time of collecting the data from the primary source originally. Similarly, the object, scope and nature of the original enquiry must also be studied. If the researcher finds differences in these, the data will remain unsuitable for the present enquiry and should not be used.

3. Adequacy of data: If the level of accuracy achieved in data is found inadequate for the purpose of the present enquiry, they will be considered as inadequate and should not be used by the researcher. The data will also be considered inadequate, if they are related to an area which may be either narrower or wider than the area of the present enquiry.

From all this we can say that it is very risky to use the already available data. The already available data should be used by the researcher only when he finds them reliable, suitable and adequate. But he should not blindly discard the use of such data if they are readily available from authentic sources and are also suitable and adequate for in that case it will not be economical to

spend time and energy in field surveys for collecting information. At times, there may be wealth of usable information in the already available data which must be used by an intelligent researcher but with due precaution.

SELECTION OF APPROPRIATE METHOD FOR DATA COLLECTION

Thus, there are various methods of data collection. As such the researcher must judiciously select the method/methods for his own study, keeping in view the following factors:

1. Nature, scope and object of enquiry: This constitutes the most important factor affecting the choice of a particular method. The method selected should be such that it suits the type of enquiry that is to be conducted by the researcher. This factor is also important in deciding whether the data already available (secondary data) are to be used or the data not yet available (primary data) are to be collected.

2. Availability of funds: Availability of funds for the research project determines to a large extent the method to be used for the collection of data. When funds at the disposal of the researcher are very limited, he will have to select a comparatively cheaper method which may not be as efficient and effective as some other costly method. Finance, in fact, is a big constraint in practice and the researcher has to act within this limitation.

3. Time factor: Availability of time has also to be taken into account in deciding a particular method of data collection. Some methods take relatively more time, whereas with others the data can be collected in a comparatively shorter duration. The time at the disposal of the researcher, thus, affects the selection of the method by which the data are to be collected.

4. Precision required: Precision required is yet another important factor to be considered at the time of selecting the method of collection of data.

But one must always remember that each method of data collection has its uses and none is superior in all situations. For instance, telephone interview method may be considered appropriate (assuming telephone population) if funds are restricted, time is also restricted and the data is to be collected in respect of few items with or without a certain degree of precision. In case funds permit and more information is desired, personal interview method may be said to be relatively better. In case time is ample, funds are limited and much information is to be gathered with no precision, then mail-questionnaire method can be regarded more reasonable. When funds are ample, time is also ample and much information with no precision is to be collected, then either personal interview or the mail-questionnaire or the joint use of these two methods may be taken as an appropriate method of collecting data. Where a wide geographic area is to be covered, the use of mail-questionnaires supplemented by personal interviews will yield more reliable results per rupee spent than either method alone. The secondary data may be used in case the researcher finds them reliable, adequate and appropriate for his research. While studying motivating influences in market researches or studying people's attitudes in psychological/social surveys, we can resort to the use of one or more of the projective techniques stated earlier. Such techniques are of immense value in case the reason is obtainable from the respondent who knows the reason but does not want to admit it or the reason relates to some underlying psychological attitude and the respondent is not aware of it. But when the respondent knows the reason and can tell the same if asked, than a non-projective questionnaire,

using direct questions, may yield satisfactory results even in case of attitude surveys. Since projective techniques are as yet in an early stage of development and with the validity of many of them remaining an open question, it is usually considered better to rely on the straight forward statistical methods with only supplementary use of projective techniques. Nevertheless, in pre-testing and in searching for hypotheses they can be highly valuable.

Thus, the most desirable approach with regard to the selection of the method depends on the nature of the particular problem and on the time and resources (money and personnel) available along with the desired degree of accuracy. But, over and above all this, much depends upon the ability and experience of the researcher. Dr. A.L. Bowley's remark in this context is very appropriate when he says that "in collection of statistical data common sense is the chief requisite and experience the chief teacher."

CASE STUDY METHOD

Meaning: The case study method is a very popular form of qualitative analysis and involves a careful and complete observation of a social unit, be that unit a person, a family, an institution, a cultural group or even the entire community. It is a method of study in depth rather than breadth. The case study places more emphasis on the full analysis of a limited number of events or conditions and their interrelations. The case study deals with the processes that take place and their interrelationship. Thus, case study is essentially an intensive investigation of the particular unit under consideration. The object of the case study method is to locate the factors that account for the behaviour-patterns of the given unit as an integrated totality.

According to H. Odum, "The case study method is a technique by which individual factor whether it be an institution or just an episode in the life of an individual or a group is analysed in its relationship to any other in the group."[5] Thus, a fairly exhaustive study of a person (as to what he does and has done, what he thinks he does and had done and what he expects to do and says he ought to do) or group is called a life or case history. Burgess has used the words "the social microscope" for the case study method."[6] Pauline V. Young describes case study as "a comprehensive study of a social unit be that unit a person, a group, a social institution, a district or a community."[7] In brief, we can say that case study method is a form of qualitative analysis where in careful and complete observation of an individual or a situation or an institution is done; efforts are made to study each and every aspect of the concerning unit in minute details and then from case data generalisations and inferences are drawn.

Characteristics: The important characteristics of the case study method are as under:

1. Under this method the researcher can take one single social unit or more of such units for his study purpose; he may even take a situation to study the same comprehensively.
2. Here the selected unit is studied intensively i.e., it is studied in minute details. Generally, the study extends over a long period of time to ascertain the natural history of the unit so as to obtain enough information for drawing correct inferences.

[5] H. Odum, *An Introduction to Social Research*, p. 229.

[6] Burgess, *Research Methods in Sociology*, p. 26 in Georges Gurvitch and W.E. Moore (Eds.) *Twentieth Century Sociology*.

[7] Pauline V. Young, *Scientific Social Surveys and Research*, p. 247.

3. In the context of this method we make complete study of the social unit covering all facets. Through this method we try to understand the complex of factors that are operative within a social unit as an integrated totality.
4 Under this method the approach happens to be qualitative and not quantitative. Mere quantitative information is not collected. Every possible effort is made to collect information concerning all aspects of life. As such, case study deepens our perception and gives us a clear insight into life. For instance, under this method we not only study how many crimes a man has done but shall peep into the factors that forced him to commit crimes when we are making a case study of a man as a criminal. The objective of the study may be to suggest ways to reform the criminal.
5. In respect of the case study method an effort is made to know the mutual inter-relationship of causal factors.
6. Under case study method the behaviour pattern of the concerning unit is studied directly and not by an indirect and abstract approach.
7. Case study method results in fruitful hypotheses along with the data which may be helpful in testing them, and thus it enables the generalised knowledge to get richer and richer. In its absence, generalised social science may get handicapped.

Evolution and scope: The case study method is a widely used systematic field research technique in sociology these days. The credit for introducing this method to the field of social investigation goes to Frederic Le Play who used it as a hand-maiden to statistics in his studies of family budgets. Herbert Spencer was the first to use case material in his comparative study of different cultures. Dr. William Healy resorted to this method in his study of juvenile delinquency, and considered it as a better method over and above the mere use of statistical data. Similarly, anthropologists, historians, novelists and dramatists have used this method concerning problems pertaining to their areas of interests. Even management experts use case study methods for getting clues to several management problems. In brief, case study method is being used in several disciplines. Not only this, its use is increasing day by day.

Assumptions: The case study method is based on several assumptions. The important assumptions may be listed as follows:

(i) The assumption of uniformity in the basic human nature in spite of the fact that human behaviour may vary according to situations.
(ii) The assumption of studying the natural history of the unit concerned.
(iii) The assumption of comprehensive study of the unit concerned.

Major phases involved: Major phases involved in case study are as follows:

(i) Recognition and determination of the status of the phenomenon to be investigated or the unit of attention.
(ii) Collection of data, examination and history of the given phenomenon.
(iii) Diagnosis and identification of causal factors as a basis for remedial or developmental treatment.
(iv) Application of remedial measures i.e., treatment and therapy (this phase is often characterised as case work).

(v) Follow-up programme to determine effectiveness of the treatment applied.

Advantages: There are several advantages of the case study method that follow from the various characteristics outlined above. Mention may be made here of the important advantages.

(i) Being an exhaustive study of a social unit, the case study method enables us to understand fully the behaviour pattern of the concerned unit. In the words of Charles Horton Cooley, "case study deepens our perception and gives us a clearer insight into life…. It gets at behaviour directly and not by an indirect and abstract approach."

(ii) Through case study a researcher can obtain a real and enlightened record of personal experiences which would reveal man's inner strivings, tensions and motivations that drive him to action along with the forces that direct him to adopt a certain pattern of behaviour.

(iii) This method enables the researcher to trace out the natural history of the social unit and its relationship with the social factors and the forces involved in its surrounding environment.

(iv) It helps in formulating relevant hypotheses along with the data which may be helpful in testing them. Case studies, thus, enable the generalised knowledge to get richer and richer.

(v) The method facilitates intensive study of social units which is generally not possible if we use either the observation method or the method of collecting information through schedules. This is the reason why case study method is being frequently used, particularly in social researches.

(vi) Information collected under the case study method helps a lot to the researcher in the task of constructing the appropriate questionnaire or schedule for the said task requires thorough knowledge of the concerning universe.

(vii) The researcher can use one or more of the several research methods under the case study method depending upon the prevalent circumstances. In other words, the use of different methods such as depth interviews, questionnaires, documents, study reports of individuals, letters, and the like is possible under case study method.

(viii) Case study method has proved beneficial in determining the nature of units to be studied along with the nature of the universe. This is the reason why at times the case study method is alternatively known as "mode of organising data".

(ix) This method is a means to well understand the past of a social unit because of its emphasis of historical analysis. Besides, it is also a technique to suggest measures for improvement in the context of the present environment of the concerned social units.

(x) Case studies constitute the perfect type of sociological material as they represent a real record of personal experiences which very often escape the attention of most of the skilled researchers using other techniques.

(xi) Case study method enhances the experience of the researcher and this in turn increases his analysing ability and skill.

(xii) This method makes possible the study of social changes. On account of the minute study of the different facets of a social unit, the researcher can well understand the social change then and now. This also facilitates the drawing of inferences and helps in maintaining the continuity of the research process. In fact, it may be considered the gateway to and at the same time the final destination of abstract knowledge.

(xiii) Case study techniques are indispensable for therapeutic and administrative purposes. They are also of immense value in taking decisions regarding several management problems. Case data are quite useful for diagnosis, therapy and other practical case problems.

Limitations: Important limitations of the case study method may as well be highlighted.

(i) Case situations are seldom comparable and as such the information gathered in case studies is often not comparable. Since the subject under case study tells history in his own words, logical concepts and units of scientific classification have to be read into it or out of it by the investigator.

(ii) Read Bain does not consider the case data as significant scientific data since they do not provide knowledge of the "impersonal, universal, non-ethical, non-practical, repetitive aspects of phenomena."[8] Real information is often not collected because the subjectivity of the researcher does enter in the collection of information in a case study.

(iii) The danger of false generalisation is always there in view of the fact that no set rules are followed in collection of the information and only few units are studied.

(iv) It consumes more time and requires lot of expenditure. More time is needed under case study method since one studies the natural history cycles of social units and that too minutely.

(v) The case data are often vitiated because the subject, according to Read Bain, may write what he thinks the investigator wants; and the greater the rapport, the more subjective the whole process is.

(vi) Case study method is based on several assumptions which may not be very realistic at times, and as such the usefulness of case data is always subject to doubt.

(vii) Case study method can be used only in a limited sphere., it is not possible to use it in case of a big society. Sampling is also not possible under a case study method.

(viii) Response of the investigator is an important limitation of the case study method. He often thinks that he has full knowledge of the unit and can himself answer about it. In case the same is not true, then consequences follow. In fact, this is more the fault of the researcher rather than that of the case method.

Conclusion: Despite the above stated limitations, we find that case studies are being undertaken in several disciplines, particularly in sociology, as a tool of scientific research in view of the several advantages indicated earlier. Most of the limitations can be removed if researchers are always conscious of these and are well trained in the modern methods of collecting case data and in the scientific techniques of assembling, classifying and processing the same. Besides, case studies, in modern times, can be conducted in such a manner that the data are amenable to quantification and statistical treatment. Possibly, this is also the reason why case studies are becoming popular day by day.

Question

1. Enumerate the different methods of collecting data. Which one is the most suitable for conducting enquiry regarding family welfare programme in India? Explain its merits and demerits.

[8] Pauline V. Young, *Scientific social surveys and research,* p. 262.

2. "It is never safe to take published statistics at their face value without knowing their meaning and limitations." Elucidate this statement by enumerating and explaining the various points which you would consider before using any published data. Illustrate your answer by examples wherever possible.

3. Examine the merits and limitations of the observation method in collecting material. Illustrate your answer with suitable examples.

4. Describe some of the major projective techniques and evaluate their significance as tools of scientific social research.

5. How does the case study method differ from the survey method? Analyse the merits and limitations of case study method in sociological research.

6. Clearly explain the difference between collection of data through questionnaires and schedules.

7. Discuss interview as a technique of data collection.

8. Write short notes on:

(a) Depth interviews;

(b) Important aspects of a questionnaire;

(c) Pantry and store audits;

(d) Thematic Apperception Test;

(e) Holtzman Inkbolt Test.

9. What are the guiding considerations in the construction of questionnaire? Explain.

10. Critically examine the following:

(i) Interviews introduce more bias than does the use of questionnaire.

(ii) Data collection through projective techniques is considered relatively more reliable.

(iii) In collection of statistical data commonsense is the chief requisite and experience the chief teacher.

11. Distinguish between an experiment and survey. Explain fully the survey method of research.

[*M. Phi. (EAFM) Exam. 1987 Raj. Uni.*]

12. "Experimental method of research is not suitable in management field." Discuss, what are the problems in the introduction of this research design in business organisation?

[*M.B.A. (Part I) Exam. 1985 Raj. Uni.*]

Appendix (i)

Guidelines for Constructing Questionnaire/Schedule

The researcher must pay attention to the following points in constructing an appropriate and effective questionnaire or a schedule:

1. The researcher must keep in view the problem he is to study for it provides the starting point for developing the Questionnaire/Schedule. He must be clear about the various aspects of his research problem to be dealt with in the course of his research project.
2. Appropriate form of questions depends on the nature of information sought, the sampled respondents and the kind of analysis intended. The researcher must decide whether to use closed or open-ended question. Questions should be simple and must be constructed with a view to their forming a logical part of a well thought out tabulation plan. The units of enumeration should also be defined precisely so that they can ensure accurate and full information.
3. Rough draft of the Questionnaire/Schedule be prepared, giving due thought to the appropriate sequence of putting questions. Questionnaires or schedules previously drafted (if available) may as well be looked into at this stage.
4. Researcher must invariably re-examine, and in case of need may revise the rough draft for a better one. Technical defects must be minutely scrutinised and removed.
5. Pilot study should be undertaken for pre-testing the questionnaire. The questionnaire may be edited in the light of the results of the pilot study.
6. Questionnaire must contain simple but straight forward directions for the respondents so that they may not feel any difficulty in answering the questions.

Appendix (ii)

Guidelines for Successful Interviewing

Interviewing is an art and one learns it by experience. However, the following points may be kept in view by an interviewer for eliciting the desired information:

1. Interviewer must plan in advance and should fully know the problem under consideration. He must choose a suitable time and place so that the interviewee may be at ease during the interview period. For this purpose some knowledge of the daily routine of the interviewee is essential.
2. Interviewer's approach must be friendly and informal. Initially friendly greetings in accordance with the cultural pattern of the interviewee should be exchanged and then the purpose of the interview should be explained.
3. All possible effort should be made to establish proper rapport with the interviewee; people are motivated to communicate when the atmosphere is favourable.
4. Interviewer must know that ability to listen with understanding, respect and curiosity is the gateway to communication, and hence must act accordingly during the interview. For all this, the interviewer must be intelligent and must be a man with self-restraint and self-discipline.
5. To the extent possible there should be a free-flowing interview and the questions must be well phrased in order to have full cooperation of the interviewee. But the interviewer must control the course of the interview in accordance with the objective of the study.
6. In case of big enquiries, where the task of collecting information is to be accomplished by several interviewers, there should be an interview guide to be observed by all so as to ensure reasonable uniformity in respect of all salient points in the study.

Appendix (iii)

Difference Between Survey and Experiment

The following points are noteworthy so far as difference between survey and experiment is concerned:

(i) Surveys are conducted in case of descriptive research studies where as experiments are a part of experimental research studies.

(ii) Survey-type research studies usually have larger samples because the percentage of responses generally happens to be low, as low as 20 to 30%, especially in mailed questionnaire studies. Thus, the survey method gathers data from a relatively large number of cases at a particular time; it is essentially cross-sectional. As against this, experimental studies generally need small samples.

(iii) Surveys are concerned with describing, recording, analysing and interpreting conditions that either exist or existed. The researcher does not manipulate the variable or arrange for events to happen. Surveys are only concerned with conditions or relationships that exist, opinions that are held, processes that are going on, effects that are evident or trends that are developing. They are primarily concerned with the present but at times do consider past events and influences as they relate to current conditions. Thus, in surveys, variables that exist or have already occurred are selected and observed.

Experimental research provides a systematic and logical method for answering the question, "What will happen if this is done when certain variables are carefully controlled or manipulated?" In fact, deliberate manipulation is a part of the experimental method. In an experiment, the researcher measures the effects of an experiment which he conducts intentionally.

(iv) Surveys are usually appropriate in case of social and behavioural sciences (because many types of behaviour that interest the researcher cannot be arranged in a realistic setting) where as experiments are mostly an essential feature of physical and natural sciences.

(v) Surveys are an example of field research where as experiments generally constitute an example of laboratory research.

(vi) Surveys are concerned with hypothesis formulation and testing the analysis of the relationship between non-manipulated variables. Experimentation provides a method of hypothesis testing. After experimenters define a problem, they propose a hypothesis. They then test the hypothesis and confirm or disconfirm it in the light of the controlled variable relationship that they have observed. The confirmation or rejection is always stated in terms of probability rather than certainty. Experimentation, thus, is the most sophisticated, exacting and powerful method for discovering and developing an organised body of knowledge. The ultimate purpose of experimentation is to generalise the variable relationships so that they may be applied outside the laboratory to a wider population of interest.*

(vii) Surveys may either be census or sample surveys. They may also be classified as social surveys, economic surveys or public opinion surveys. Whatever be their type, the method of data collection happens to be either observation, or interview or questionnaire/opinionnaire or some projective technique(s). Case study method can as well be used. But in case of experiments, data are collected from several readings of experiments.

(viii) In case of surveys, research design must be rigid, must make enough provision for protection against bias and must maximise reliability as the aim happens to be to obtain complete and accurate information. Research design in case of experimental studies, apart reducing bias and ensuring reliability, must permit drawing inferences about causality.

(ix) Possible relationships between the data and the unknowns in the universe can be studied through surveys where as experiments are meant to determine such relationships.

(x) Causal analysis is considered relatively more important in experiments where as in most social and business surveys our interest lies in understanding and controlling relationships between variables and as such correlation analysis is relatively more important in surveys.

* John W. Best and James V. Kahn, "*Research in Education*", 5th ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 1986, p.111.

7

Processing and Analysis of Data

The data, after collection, has to be processed and analysed in accordance with the outline laid down for the purpose at the time of developing the research plan. This is essential for a scientific study and for ensuring that we have all relevant data for making contemplated comparisons and analysis. Technically speaking, processing implies editing, coding, classification and tabulation of collected data so that they are amenable to analysis. The term analysis refers to the computation of certain measures along with searching for patterns of relationship that exist among data-groups. Thus, "in the process of analysis, relationships or differences supporting or conflicting with original or new hypotheses should be subjected to statistical tests of significance to determine with what validity data can be said to indicate any conclusions".[1] But there are persons (Selltiz, Jahoda and others) who do not like to make difference between processing and analysis. They opine that analysis of data in a general way involves a number of closely related operations which are performed with the purpose of summarising the collected data and organising these in such a manner that they answer the research question(s). We, however, shall prefer to observe the difference between the two terms as stated here in order to understand their implications more clearly.

PROCESSING OPERATIONS

With this brief introduction concerning the concepts of processing and analysis, we can now proceed with the explanation of all the processing operations.

1. Editing: Editing of data is a process of examining the collected raw data (specially in surveys) to detect errors and omissions and to correct these when possible. As a matter of fact, editing involves a careful scrutiny of the completed questionnaires and/or schedules. Editing is done to assure that the data are accurate, consistent with other facts gathered, uniformly entered, as completed as possible and have been well arranged to facilitate coding and tabulation.

With regard to points or stages at which editing should be done, one can talk of field editing and central editing. *Field editing* consists in the review of the reporting forms by the investigator for completing (translating or rewriting) what the latter has written in abbreviated and/or in illegible form

[1] G.B. Giles, *Marketing,* p. 44.

at the time of recording the respondents' responses. This type of editing is necessary in view of the fact that individual writing styles often can be difficult for others to decipher. This sort of editing should be done as soon as possible after the interview, preferably on the very day or on the next day. While doing field editing, the investigator must restrain himself and must not correct errors of omission by simply guessing what the informant would have said if the question had been asked.

Central editing should take place when all forms or schedules have been completed and returned to the office. This type of editing implies that all forms should get a thorough editing by a single editor in a small study and by a team of editors in case of a large inquiry. Editor(s) may correct the obvious errors such as an entry in the wrong place, entry recorded in months when it should have been recorded in weeks, and the like. In case of inappropriate on missing replies, the editor can sometimes determine the proper answer by reviewing the other information in the schedule. At times, the respondent can be contacted for clarification. The editor must strike out the answer if the same is inappropriate and he has no basis for determining the correct answer or the response. In such a case an editing entry of 'no answer' is called for. All the wrong replies, which are quite obvious, must be dropped from the final results, especially in the context of mail surveys.

Editors must keep in view several points while performing their work: (a) They should be familiar with instructions given to the interviewers and coders as well as with the editing instructions supplied to them for the purpose. (b) While crossing out an original entry for one reason or another, they should just draw a single line on it so that the same may remain legible. (c) They must make entries (if any) on the form in some distinctive colur and that too in a standardised form. (d) They should initial all answers which they change or supply. (e) Editor's initials and the date of editing should be placed on each completed form or schedule.

2. Coding: Coding refers to the process of assigning numerals or other symbols to answers so that responses can be put into a limited number of categories or classes. Such classes should be appropriate to the research problem under consideration. They must also possess the characteristic of exhaustiveness (i.e., there must be a class for every data item) and also that of mutual exclusively which means that a specific answer can be placed in one and only one cell in a given category set. Another rule to be observed is that of unidimensionality by which is meant that every class is defined in terms of only one concept.

Coding is necessary for efficient analysis and through it the several replies may be reduced to a small number of classes which contain the critical information required for analysis. Coding decisions should usually be taken at the designing stage of the questionnaire. This makes it possible to precode the questionnaire choices and which in turn is helpful for computer tabulation as one can straight forward key punch from the original questionnaires. But in case of hand coding some standard method may be used. One such standard method is to code in the margin with a coloured pencil. The other method can be to transcribe the data from the questionnaire to a coding sheet. Whatever method is adopted, one should see that coding errors are altogether eliminated or reduced to the minimum level.

3. Classification: Most research studies result in a large volume of raw data which must be reduced into homogeneous groups if we are to get meaningful relationships. This fact necessitates classification of data which happens to be the process of arranging data in groups or classes on the basis of common characteristics. Data having a common characteristic are placed in one class and in this

way the entire data get divided into a number of groups or classes. Classification can be one of the following two types, depending upon the nature of the phenomenon involved:

(a) *Classification according to attributes:* As stated above, data are classified on the basis of common characteristics which can either be descriptive (such as literacy, sex, honesty, etc.) or numerical (such as weight, height, income, etc.). Descriptive characteristics refer to qualitative phenomenon which cannot be measured quantitatively; only their presence or absence in an individual item can be noticed. Data obtained this way on the basis of certain attributes are known as *statistics of attributes* and their classification is said to be classification according to attributes.

Such classification can be simple classification or manifold classification. In simple classification we consider only one attribute and divide the universe into two classes—one class consisting of items possessing the given attribute and the other class consisting of items which do not possess the given attribute. But in manifold classification we consider two or more attributes simultaneously, and divide that data into a number of classes (total number of classes of final order is given by 2^n, where n = number of attributes considered).* Whenever data are classified according to attributes, the researcher must see that the attributes are defined in such a manner that there is least possibility of any doubt/ambiguity concerning the said attributes.

(b) *Classification according to class-intervals:* Unlike descriptive characteristics, the numerical characteristics refer to quantitative phenomenon which can be measured through some statistical units. Data relating to income, production, age, weight, etc. come under this category. Such data are known as *statistics of variables* and are classified on the basis of class intervals. For instance, persons whose incomes, say, are within Rs 201 to Rs 400 can form one group, those whose incomes are within Rs 401 to Rs 600 can form another group and so on. In this way the entire data may be divided into a number of groups or classes or what are usually called, 'class-intervals.' Each group of class-interval, thus, has an upper limit as well as a lower limit which are known as class limits. The difference between the two class limits is known as class magnitude. We may have classes with equal class magnitudes or with unequal class magnitudes. The number of items which fall in a given class is known as the frequency of the given class. All the classes or groups, with their respective frequencies taken together and put in the form of a table, are described as group frequency distribution or simply frequency distribution. Classification according to class intervals usually involves the following three main problems:

(i) How may classes should be there? What should be their magnitudes?

There can be no specific answer with regard to the number of classes. The decision about this calls for skill and experience of the researcher. However, the objective should be to display the data in such a way as to make it meaningful for the analyst. Typically, we may have 5 to 15 classes. With regard to the second part of the question, we can say that, to the extent possible, class-intervals should be of equal magnitudes, but in some cases unequal magnitudes may result in better classification. Hence the

* Classes of the final order are those classes developed on the basis of '*n*' attributes considered. For example, if attributes *A* and *B* are studied and their presence is denoted by *A* and *B* respectively and absence by *a* and *b* respectively, then we have four classes of final order viz., class *AB*, class *Ab*, class *aB*, and class *ab*.

researcher's objective judgement plays an important part in this connection. Multiples of 2, 5 and 10 are generally preferred while determining class magnitudes. Some statisticians adopt the following formula, suggested by H.A. Sturges, determining the size of class interval:

$$i = R/(1 + 3.3 \log N)$$

where

i = size of class interval;

R = Range (i.e., difference between the values of the largest item and smallest item among the given items);

N = Number of items to be grouped.

It should also be kept in mind that in case one or two or very few items have very high or very low values, one may use what are known as open-ended intervals in the overall frequency distribution. Such intervals may be expressed like under Rs 500 or Rs 10001 and over. Such intervals are generally not desirable, but often cannot be avoided. The researcher must always remain conscious of this fact while deciding the issue of the total number of class intervals in which the data are to be classified.

(ii) How to choose class limits?

While choosing class limits, the researcher must take into consideration the criterion that the mid-point (generally worked out first by taking the sum of the upper limit and lower limit of a class and then divide this sum by 2) of a class-interval and the actual average of items of that class interval should remain as close to each other as possible. Consistent with this, the class limits should be located at multiples of 2, 5, 10, 20, 100 and such other figures. Class limits may generally be stated in any of the following forms:

Exclusive type class intervals: They are usually stated as follows:

10–20

20–30

30–40

40–50

The above intervals should be read as under:

10 and under 20

20 and under 30

30 and under 40

40 and under 50

Thus, under the exclusive type class intervals, the items whose values are equal to the upper limit of a class are grouped in the next higher class. For example, an item whose value is exactly 30 would be put in 30–40 class interval and not in 20–30 class interval. In simple words, we can say that under exclusive type class intervals, the upper limit of a class interval is excluded and items with values less than the upper limit (but not less than the lower limit) are put in the given class interval.

Inclusive type class intervals: They are usually stated as follows:

11–20
21–30
31–40
41–50

In inclusive type class intervals the upper limit of a class interval is also included in the concerning class interval. Thus, an item whose value is 20 will be put in 11–20 class interval. The stated upper limit of the class interval 11–20 is 20 but the real limit is 20.99999 and as such 11–20 class interval really means 11 and under 21.

When the phenomenon under consideration happens to be a discrete one (i.e., can be measured and stated only in integers), then we should adopt inclusive type classification. But when the phenomenon happens to be a continuous one capable of being measured in fractions as well, we can use exclusive type class intervals.*

(iii) How to determine the frequency of each class?

This can be done either by tally sheets or by mechanical aids. Under the technique of tally sheet, the class-groups are written on a sheet of paper (commonly known as the tally sheet) and for each item a stroke (usually a small vertical line) is marked against the class group in which it falls. The general practice is that after every four small vertical lines in a class group, the fifth line for the item falling in the same group, is indicated as horizontal line through the said four lines and the resulting flower (IIII) represents five items. All this facilitates the counting of items in each one of the class groups. An illustrative tally sheet can be shown as under:

Table 7.1: An Illustrative Tally Sheet for Determining the Number of 70 Families in Different Income Groups

Income groups (Rupees)	*Tally mark*	*Number of families or (Class frequency)*
Below 400	𝍸 𝍸 III	13
401–800	𝍸 𝍸 𝍸 𝍸	20
801–1200	𝍸 𝍸 II	12
1201–1600	𝍸 𝍸 𝍸 III	18
1601 and above	𝍸 II	7
Total		70

Alternatively, class frequencies can be determined, specially in case of large inquires and surveys, by mechanical aids i.e., with the help of machines viz., sorting machines that are available for the purpose. Some machines are hand operated, whereas other work with electricity. There are machines

* The stated limits of class intervals are different than true limits. We should use true or real limits keeping in view the nature of the given phenomenon.

which can sort out cards at a speed of something like 25000 cards per hour. This method is fast but expensive.

4. Tabulation: When a mass of data has been assembled, it becomes necessary for the researcher to arrange the same in some kind of concise and logical order. This procedure is referred to as tabulation. Thus, tabulation is the process of summarising raw data and displaying the same in compact form (i.e., in the form of statistical tables) for further analysis. In a broader sense, tabulation is an orderly arrangement of data in columns and rows.

Tabulation is essential because of the following reasons.

1. It conserves space and reduces explanatory and descriptive statement to a minimum.
2. It facilitates the process of comparison.
3. It facilitates the summation of items and the detection of errors and omissions.
4. It provides a basis for various statistical computations.

Tabulation can be done by hand or by mechanical or electronic devices. The choice depends on the size and type of study, cost considerations, time pressures and the availaibility of tabulating machines or computers. In relatively large inquiries, we may use mechanical or computer tabulation if other factors are favourable and necessary facilities are available. Hand tabulation is usually preferred in case of small inquiries where the number of questionnaires is small and they are of relatively short length. Hand tabulation may be done using the direct tally, the list and tally or the card sort and count methods. When there are simple codes, it is feasible to tally directly from the questionnaire. Under this method, the codes are written on a sheet of paper, called tally sheet, and for each response a stroke is marked against the code in which it falls. Usually after every four strokes against a particular code, the fifth response is indicated by drawing a diagonal or horizontal line through the strokes. These groups of five are easy to count and the data are sorted against each code conveniently. In the listing method, the code responses may be transcribed onto a large work-sheet, allowing a line for each questionnaire. This way a large number of questionnaires can be listed on one work sheet. Tallies are then made for each question. The card sorting method is the most flexible hand tabulation. In this method the data are recorded on special cards of convenient size and shape with a series of holes. Each hole stands for a code and when cards are stacked, a needle passes through particular hole representing a particular code. These cards are then separated and counted. In this way frequencies of various codes can be found out by the repetition of this technique. We can as well use the mechanical devices or the computer facility for tabulation purpose in case we want quick results, our budget permits their use and we have a large volume of straight forward tabulation involving a number of cross-breaks.

Tabulation may also be classified as simple and complex tabulation. The former type of tabulation gives information about one or more groups of independent questions, whereas the latter type of tabulation shows the division of data in two or more categories and as such is deigned to give information concerning one or more sets of inter-related questions. Simple tabulation generally results in one-way tables which supply answers to questions about one characteristic of data only. As against this, complex tabulation usually results in two-way tables (which give information about two inter-related characteristics of data), three-way tables (giving information about three interrelated characteristics of data) or still higher order tables, also known as manifold tables, which supply

information about several interrelated characteristics of data. Two-way tables, three-way tables or manifold tables are all examples of what is sometimes described as cross tabulation.

Generally accepted principles of tabulation: Such principles of tabulation, particularly of constructing statistical tables, can be briefly states as follows:*

1. Every table should have a clear, concise and adequate title so as to make the table intelligible without reference to the text and this title should always be placed just above the body of the table.
2. Every table should be given a distinct number to facilitate easy reference.
3. The column headings (captions) and the row headings (stubs) of the table should be clear and brief.
4. The units of measurement under each heading or sub-heading must always be indicated.
5. Explanatory footnotes, if any, concerning the table should be placed directly beneath the table, along with the reference symbols used in the table.
6. Source or sources from where the data in the table have been obtained must be indicated just below the table.
7. Usually the columns are separated from one another by lines which make the table more readable and attractive. Lines are always drawn at the top and bottom of the table and below the captions.
8. There should be thick lines to separate the data under one class from the data under another class and the lines separating the sub-divisions of the classes should be comparatively thin lines.
9. The columns may be numbered to facilitate reference.
10. Those columns whose data are to be compared should be kept side by side. Similarly, percentages and/or averages must also be kept close to the data.
11. It is generally considered better to approximate figures before tabulation as the same would reduce unnecessary details in the table itself.
12. In order to emphasise the relative significance of certain categories, different kinds of type, spacing and indentations may be used.
13. It is important that all column figures be properly aligned. Decimal points and (+) or (–) signs should be in perfect alignment.
14. Abbreviations should be avoided to the extent possible and ditto marks should not be used in the table.
15. Miscellaneous and exceptional items, if any, should be usually placed in the last row of the table.
16. Table should be made as logical, clear, accurate and simple as possible. If the data happen to be very large, they should not be crowded in a single table for that would make the table unwieldy and inconvenient.
17. Total of rows should normally be placed in the extreme right column and that of columns should be placed at the bottom.

* All these points constitute the characteristics of a good table.

18. The arrangement of the categories in a table may be chronological, geographical, alphabetical or according to magnitude to facilitate comparison. Above all, the table must suit the needs and requirements of an investigation.

SOME PROBLEMS IN PROCESSING

We can take up the following two problems of processing the data for analytical purposes:

(a) *The problem concerning "Don't know" (or DK) responses:* While processing the data, the researcher often comes across some responses that are difficult to handle. One category of such responses may be 'Don't Know Response' or simply DK response. When the DK response group is small, it is of little significance. But when it is relatively big, it becomes a matter of major concern in which case the question arises: Is the question which elicited DK response useless? The answer depends on two points viz., the respondent actually may not know the answer or the researcher may fail in obtaining the appropriate information. In the first case the concerned question is said to be alright and DK response is taken as legitimate DK response. But in the second case, DK response is more likely to be a failure of the questioning process.

How DK responses are to be dealt with by researchers? The best way is to design better type of questions. Good rapport of interviewers with respondents will result in minimising DK responses. But what about the DK responses that have already taken place? One way to tackle this issue is to estimate the allocation of DK answers from other data in the questionnaire. The other way is to keep DK responses as a separate category in tabulation where we can consider it as a separate reply category if DK responses happen to be legitimate, otherwise we should let the reader make his own decision. Yet another way is to assume that DK responses occur more or less randomly and as such we may distribute them among the other answers in the ratio in which the latter have occurred. Similar results will be achieved if all DK replies are excluded from tabulation and that too without inflating the actual number of other responses.

(b) *Use or percentages:* Percentages are often used in data presentation for they simplify numbers, reducing all of them to a 0 to 100 range. Through the use of percentages, the data are reduced in the standard form with base equal to 100 which fact facilitates relative comparisons. While using percentages, the following rules should be kept in view by researchers:

1. Two or more percentages must not be averaged unless each is weighted by the group size from which it has been derived.
2. Use of too large percentages should be avoided, since a large percentage is difficult to understand and tends to confuse, defeating the very purpose for which percentages are used.
3. Percentages hide the base from which they have been computed. If this is not kept in view, the real differences may not be correctly read.
4. Percentage decreases can never exceed 100 per cent and as such for calculating the percentage of decrease, the higher figure should invariably be taken as the base.
5. Percentages should generally be worked out in the direction of the causal-factor in case of two-dimension tables and for this purpose we must select the more significant factor out of the two given factors as the causal factor.

ELEMENTS/TYPES OF ANALYSIS

As stated earlier, by analysis we mean the computation of certain indices or measures along with searching for patterns of relationship that exist among the data groups. Analysis, particularly in case of survey or experimental data, involves estimating the values of unknown parameters of the population and testing of hypotheses for drawing inferences. Analysis may, therefore, be categorised as descriptive analysis and inferential analysis (Inferential analysis is often known as statistical analysis). "*Descriptive analysis* is largely the study of distributions of one variable. This study provides us with profiles of companies, work groups, persons and other subjects on any of a multiple of characteristics such as size. Composition, efficiency, preferences, etc."[2]. this sort of analysis may be in respect of one variable (described as unidimensional analysis), or in respect of two variables (described as bivariate analysis) or in respect of more than two variables (described as multivariate analysis). In this context we work out various measures that show the size and shape of a distribution(s) along with the study of measuring relationships between two or more variables.

We may as well talk of correlation analysis and causal analysis. *Correlation analysis* studies the joint variation of two or more variables for determining the amount of correlation between two or more variables. *Causal analysis* is concerned with the study of how one or more variables affect changes in another variable. It is thus a study of functional relationships existing between two or more variables. This analysis can be termed as regression analysis. Causal analysis is considered relatively more important in experimental researches, whereas in most social and business researches our interest lies in understanding and controlling relationships between variables then with determining causes *per se* and as such we consider correlation analysis as relatively more important.

In modern times, with the availability of computer facilities, there has been a rapid development of *multivariate analysis* which may be defined as "all statistical methods which simultaneously analyse more than two variables on a sample of observations"[3]. Usually the following analyses[*] are involved when we make a reference of multivariate analysis:

(a) *Multiple regression analysis:* This analysis is adopted when the researcher has one dependent variable which is presumed to be a function of two or more independent variables. The objective of this analysis is to make a prediction about the dependent variable based on its covariance with all the concerned independent variables.

(b) *Multiple discriminant analysis:* This analysis is appropriate when the researcher has a single dependent variable that cannot be measured, but can be classified into two or more groups on the basis of some attribute. The object of this analysis happens to be to predict an entity's possibility of belonging to a particular group based on several predictor variables.

(c) *Multivariate analysis of variance* (*or multi-ANOVA*): This analysis is an extension of two-way ANOVA, wherein the ratio of among group variance to within group variance is worked out on a set of variables.

(d) *Canonical analysis:* This analysis can be used in case of both measurable and non-measurable variables for the purpose of simultaneously predicting a set of dependent variables from their joint covariance with a set of independent variables.

[2] C. William Emory, *Business Research Methods*, p. 356.

[3] Jagdish N. Sheth, "The Multivariate Revolution in Marketing Research", *Journal of Marketing*, Vol. 35, No. 1 (Jan. 1971), pp. 13–19.

[*] Readers are referred to standard texts for more details about these analyses.

Inferential analysis is concerned with the various tests of significance for testing hypotheses in order to determine with what validity data can be said to indicate some conclusion or conclusions. It is also concerned with the estimation of population values. It is mainly on the basis of inferential analysis that the task of interpretation (i.e., the task of drawing inferences and conclusions) is performed.

STATISTICS IN RESEARCH

The role of statistics in research is to function as a tool in designing research, analysing its data and drawing conclusions therefrom. Most research studies result in a large volume of raw data which must be suitably reduced so that the same can be read easily and can be used for further analysis. Clearly the science of statistics cannot be ignored by any research worker, even though he may not have occasion to use statistical methods in all their details and ramifications. Classification and tabulation, as stated earlier, achieve this objective to some extent, but we have to go a step further and develop certain indices or measures to summarise the collected/classified data. Only after this we can adopt the process of generalisation from small groups (i.e., samples) to population. If fact, there are two major areas of statistics viz., descriptive statistics and inferential statistics. *Descriptive statistics* concern the development of certain indices from the raw data, whereas inferential statistics concern with the process of generalisation. *Inferential statistics* are also known as sampling statistics and are mainly concerned with two major type of problems: (i) the estimation of population parameters, and (ii) the testing of statistical hypotheses.

The important statistical measures[*] that are used to summarise the survey/research data are:

(1) measures of central tendency or statistical averages; (2) measures of dispersion; (3) measures of asymmetry (skewness); (4) measures of relationship; and (5) other measures.

Amongst the measures of central tendency, the three most important ones are the arithmetic average or mean, median and mode. Geometric mean and harmonic mean are also sometimes used.

From among the measures of dispersion, variance, and its square root—the standard deviation are the most often used measures. Other measures such as mean deviation, range, etc. are also used. For comparison purpose, we use mostly the coefficient of standard deviation or the coefficient of variation.

In respect of the measures of skewness and kurtosis, we mostly use the first measure of skewness based on mean and mode or on mean and median. Other measures of skewness, based on quartiles or on the methods of moments, are also used sometimes. Kurtosis is also used to measure the peakedness of the curve of the frequency distribution.

Amongst the measures of relationship, Karl Pearson's coefficient of correlation is the frequently used measure in case of statistics of variables, whereas Yule's coefficient of association is used in case of statistics of attributes. Multiple correlation coefficient, partial correlation coefficient, regression analysis, etc., are other important measures often used by a researcher.

Index numbers, analysis of time series, coefficient of contingency, etc., are other measures that may as well be used by a researcher, depending upon the nature of the problem under study.

We give below a brief outline of some important measures (our of the above listed measures) often used in the context of research studies.

[*] One may read any standard text book on statistical methods for details about these measures.

MEASURES OF CENTRAL TENDENCY

Measures of central tendency (or statistical averages) tell us the point about which items have a tendency to cluster. Such a measure is considered as the most representative figure for the entire mass of data. Measure of central tendency is also known as statistical average. Mean, median and mode are the most popular averages. *Mean*, also known as arithmetic average, is the most common measure of central tendency and may be defined as the value which we get by dividing the total of the values of various given items in a series by the total number of items. we can work it out as under:

$$\text{Mean (or } \bar{X})^{*} = \frac{\sum X_i}{n} = \frac{X_1 + X_2 + \ldots + X_n}{n}$$

where $\bar{X}$ = The symbol we use for mean (pronounced as X bar)

$\sum$ = Symbol for summation

X_i = Value of the ith item X, $i = 1, 2, \ldots, n$

n = total number of items

In case of a frequency distribution, we can work out mean in this way:

$$\bar{X} = \frac{\sum f_i X_i}{\sum f_i} = \frac{f_1 X_1 + f_2 X_2 + \ldots + f_n X_n}{f_1 + f_2 + \ldots + f_n = n}$$

Sometimes, instead of calculating the simple mean, as stated above, we may workout the weighted mean for a realistic average. The weighted mean can be worked out as follows:

$$\bar{X}_w = \frac{\sum w_i X_i}{\sum w_i}$$

where $\bar{X}_w$ = Weighted item

w_i = weight of ith item X

X_i = value of the ith item X

Mean is the simplest measurement of central tendency and is a widely used measure. Its chief use consists in summarising the essential features of a series and in enabling data to be compared. It is amenable to algebraic treatment and is used in further statistical calculations. It is a relatively stable measure of central tendency. But it suffers from some limitations viz., it is unduly affected by extreme items; it may not coincide with the actual value of an item in a series, and it may lead to wrong impressions, particularly when the item values are not given with the average. However, mean is better than other averages, specially in economic and social studies where direct quantitative measurements are possible.

Median is the value of the middle item of series when it is arranged in ascending or descending order of magnitude. It divides the series into two halves; in one half all items are less than median, whereas in the other half all items have values higher than median. If the values of the items arranged in the ascending order are: 60, 74, 80, 90, 95, 100, then the value of the 4th item viz., 88 is the value of median. We can also write thus:

* If we use assumed average A, then mean would be worked out as under:

$\bar{X} = A + \frac{\sum(X_i - A)}{n}$ or $\bar{X} = A + \frac{\sum f_i(X_i - A)}{\sum f_i}$, in case of frequency distribution. This is also known as short cut method of finding $\bar{X}$.

$$\text{Median } (M) = \text{Value of } \left(\frac{n+1}{2}\right)\text{th item}$$

Median is a positional average and is used only in the context of qualitative phenomena, for example, in estimating intelligence, etc., which are often encountered in sociological fields. Median is not useful where items need to be assigned relative importance and weights. It is not frequently used in sampling statistics.

Mode is the most commonly or frequently occurring value in a series. The mode in a distribution is that item around which there is maximum concentration. In general, mode is the size of the item which has the maximum frequency, but at items such an item may not be mode on account of the effect of the frequencies of the neighbouring items. Like median, mode is a positional average and is not affected by the values of extreme items. it is, therefore, useful in all situations where we want to eliminate the effect of extreme variations. Mode is particularly useful in the study of popular sizes. For example, a manufacturer of shoes is usually interested in finding out the size most in demand so that he may manufacture a larger quantity of that size. In other words, he wants a modal size to be determined for median or mean size would not serve his purpose. but there are certain limitations of mode as well. For example, it is not amenable to algebraic treatment and sometimes remains indeterminate when we have two or more model values in a series. It is considered unsuitable in cases where we want to give relative importance to items under consideration.

Geometric mean is also useful under certain conditions. It is defined as the *n*th root of the product of the values of *n* times in a given series. Symbolically, we can put it thus:

$$\text{Geometric mean (or G.M.)} = \sqrt[n]{\pi X_i}$$

$$= \sqrt[n]{X_1 \cdot X_2 \cdot X_3 \ldots X_n}$$

where

G.M. = geometric mean,

n = number of items.

X_i = ith value of the variable X

π = conventional product notation

For instance, the geometric mean of the numbers, 4, 6, and 9 is worked out as

$$\text{G.M.} = \sqrt[3]{4.6.9}$$

$$= 6$$

The most frequently used application of this average is in the determination of average per cent of change i.e., it is often used in the preparation of index numbers or when we deal in ratios.

Harmonic mean is defined as the reciprocal of the average of reciprocals of the values of items of a series. Symbolically, we can express it as under:

$$\text{Harmonic mean (H.M.)} = \text{Rec.}\frac{\sum \text{Rec} X_i}{n}$$

$$= \text{Rec.}\frac{\text{Rec.}\, X_1 + \text{Rec.}\, X_2 + \ldots + \text{Rec.}\, X_n}{n}$$

where

H.M. = Harmonic mean

Rec. = Reciprocal

X_i = ith value of the variable X

n = number of items

For instance, the harmonic mean of the numbers 4, 5, and 10 is worked out as

$$\text{H.M.} = \text{Rec}\frac{1/4 + 1/5 + 1/10}{3} = \text{Rec}\ \frac{\frac{15 + 12 + 6}{60}}{3}$$

$$= \text{Rec}\left(\frac{33}{60} \times \frac{1}{3}\right) = \frac{60}{11} = 5.45$$

Harmonic mean is of limited application, particularly in cases where time and rate are involved. The harmonic mean gives largest weight to the smallest item and smallest weight to the largest item. As such it is used in cases like time and motion study where time is variable and distance constant.

From what has been stated above, we can say that there are several types of statistical averages. Researcher has to make a choice for some average. There are no hard and fast rules for the selection of a particular average in statistical analysis for the selection of an average mostly depends on the nature, type of objectives of the research study. One particular type of average cannot be taken as appropriate for all types of studies. The chief characteristics and the limitations of the various averages must be kept in view; discriminate use of average is very essential for sound statistical analysis.

MEASURES OF DISPERSION

An averages can represent a series only as best as a single figure can, but it certainly cannot reveal the entire story of any phenomenon under study. Specially it fails to give any idea about the scatter of the values of items of a variable in the series around the true value of average. In order to measure this scatter, statistical devices called measures of dispersion are calculated. Important measures of dispersion are (a) range, (b) mean deviation, and (c) standard deviation.

(a) *Range* is the simplest possible measure of dispersion and is defined as the difference between the values of the extreme items of a series. Thus,

$$\text{Range} = \begin{pmatrix}\text{Highest value of an}\\ \text{item in a series}\end{pmatrix} - \begin{pmatrix}\text{Lowest value of an}\\ \text{item in a series}\end{pmatrix}$$

The utility of range is that it gives an idea of the variability very quickly, but the drawback is that range is affected very greatly by fluctuations of sampling. Its value is never stable, being based on only two values of the variable. As such, range is mostly used as a rough measure of variability and is not considered as an appropriate measure in serious research studies.

(b) *Mean deviation* is the average of difference of the values of items from some average of the series. Such a difference is technically described as deviation. In calculating mean deviation we ignore the minus sign of deviations while taking their total for obtaining the mean deviation. Mean deviation is, thus, obtained as under:

Mean deviation from mean $(\delta_{\bar{X}}) = \dfrac{\Sigma|X_i - \bar{X}|}{n}$, if deviations, $|X_i - \bar{X}|$, are obtained from or arithmetic average.

Mean deviation from median $(\delta_m) = \dfrac{\Sigma|X_i - M|}{n}$, if deviations, $|X_i - M|$, are obtained from or from median

Mean deviation from mode $(\delta_z) = \dfrac{\Sigma|X_i - Z|}{n}$, if deviations, $|X_i - Z|$, are obtained from mode.

where δ = Symbol for mean deviation (pronounced as delta);
X_i = ith values of the variable X;
n = number of items;
$\bar{X}$ = Arithmetic average;
M = Median;
Z = Mode.

When mean deviation is divided by the average used in finding out the mean deviation itself, the resulting quantity is described as the *coefficient of mean deviation*. Coefficient of mean deviation is a relative measure of dispersion and is comparable to similar measure of other series. Mean deviation and its coefficient are used in statistical studies for judging the variability, and thereby render the study of central tendency of a series more precise by throwing light on the typicalness of an average. It is a better measure of variability than range as it takes into consideration the values of all items of a series. Even then it is not a frequently used measure as it is not amenable to algebraic process.

(c) *Standard deviation* is most widely used measure of dispersion of a series and is commonly denoted by the symbol 'σ' (pronounced as sigma). Standard deviation is defined as the square-root of the average of squares of deviations, when such deviations for the values of individual items in a series are obtained from the arithmetic average. It is worked out as under:

$$\text{Standard deviation}^{*}\ (\sigma) = \sqrt{\frac{\Sigma(X_i - \bar{X})^2}{n}}$$

*If we use assumed average, A, in place of $\bar{X}$ while finding deviations, then standard deviation would be worked out as under:

$$\sigma = \sqrt{\frac{\Sigma(X_i - A)^2}{n} - \left(\frac{\Sigma(X_i - A)}{n}\right)^2}$$

Or

$$\sigma = \sqrt{\frac{\Sigma f_i(X_i - A)^2}{\Sigma f_i} - \left(\frac{\Sigma f_i(X_i - A)}{\Sigma f_i}\right)^2}, \text{ in case of frequency distribution.}$$

This is also known as the short-cut method of finding σ.

Or

$$\text{Standard deviation}(\sigma) = \sqrt{\frac{\Sigma f_i \left(X_i - \bar{X}\right)^2}{\Sigma f_i}}$$, in case of frequency distribution

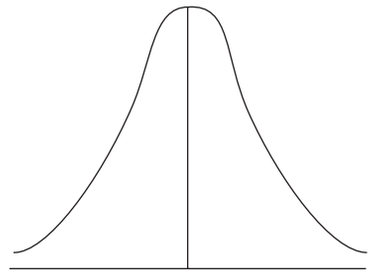
where f_i means the frequency of the *i*th item.

When we divide the standard deviation by the arithmetic average of the series, the resulting quantity is known as *coefficient of standard deviation which* happens to be a relative measure and is often used for comparing with similar measure of other series. When this coefficient of standard deviation is multiplied by 100, the resulting figure is known as *coefficient of variation*. Sometimes, we work out the square of standard deviation, known as *variance*, which is frequently used in the context of analysis of variation.

The standard deviation (along with several related measures like variance, coefficient of variation, etc.) is used mostly in research studies and is regarded as a very satisfactory measure of dispersion in a series. It is amenable to mathematical manipulation because the algebraic signs are not ignored in its calculation (as we ignore in case of mean deviation). It is less affected by fluctuations of sampling. These advantages make standard deviation and its coefficient a very popular measure of the scatteredness of a series. It is popularly used in the context of estimation and testing of hypotheses.

MEASURES OF ASYMMETRY (SKEWNESS)

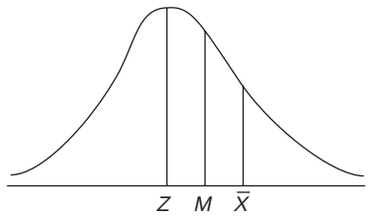
When the distribution of item in a series happens to be perfectly symmetrical, we then have the following type of curve for the distribution:



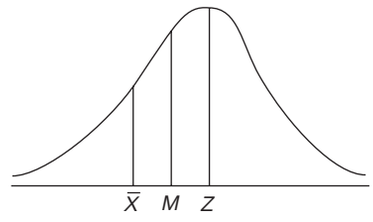
Curve showing no skewness in which case we have $\bar{X} = M = Z$

Fig. 7.1

Such a curve is technically described as a *normal curve* and the relating distribution as normal distribution. Such a curve is perfectly bell shaped curve in which case the value of $\bar{X}$ or M or Z is just the same and skewness is altogether absent. But if the curve is distorted (whether on the right side or on the left side), we have asymmetrical distribution which indicates that there is skewness. If the curve is distorted on the right side, we have positive skewness but when the curve is distorted towards left, we have negative skewness as shown here under:



Curve showing positive skewness
In case of positive skewness we have:
$Z < M < \bar{X}$



Curve showing negative skewness
In case of negative skewness we have:
$\bar{X} < M < Z$

Fig. 7.2

Skewness is, thus, a measure of asymmetry and shows the manner in which the items are clustered around the average. In a symmetrical distribution, the items show a perfect balance on either side of the mode, but in a skew distribution the balance is thrown to one side. The amount by which the balance exceeds on one side measures the skewness of the series. The difference between the mean, median or the mode provides an easy way of expressing skewness in a series. In case of positive skewness, we have $Z < M < \bar{X}$ and in case of negative skewness we have $\bar{X} < M < Z$. Usually we measure skewness in this way:

Skewness = $\bar{X} - Z$ and its coefficient (j) is worked

out as $j = \dfrac{\bar{X} - Z}{\sigma}$

In case Z is not well defined, then we work out skewness as under:

Skewness = $3(\bar{X} - M)$ and its coefficient (j) is worked

out as $j = \dfrac{3\left(\bar{X} - M\right)}{\sigma}$

The significance of skewness lies in the fact that through it one can study the formation of series and can have the idea about the shape of the curve, whether normal or otherwise, when the items of a given series are plotted on a graph.

Kurtosis is the measure of flat-toppedness of a curve. A bell shaped curve or the normal curve is Mesokurtic because it is kurtic in the centre; but if the curve is relatively more peaked than the normal curve, it is called Leptokurtic whereas a curve is more flat than the normal curve, it is called Platykurtic. In brief, Kurtosis is the humpedness of the curve and points to the nature of distribution of items in the middle of a series.

It may be pointed out here that knowing the shape of the distribution curve is crucial to the use of statistical methods in research analysis since most methods make specific assumptions about the nature of the distribution curve.

MEASURES OF RELATIONSHIP

So far we have dealt with those statistical measures that we use in context of univariate population i.e., the population consisting of measurement of only one variable. But if we have the data on two variables, we are said to have a bivariate population and if the data happen to be on more than two variables, the population is known as multivariate population. If for every measurement of a variable, *X*, we have corresponding value of a second variable, *Y*, the resulting pairs of values are called a bivariate population. In addition, we may also have a corresponding value of the third variable, *Z*, or the forth variable, *W*, and so on, the resulting pairs of values are called a multivariate population. In case of bivariate or multivariate populations, we often wish to know the relation of the two and/or more variables in the data to one another. We may like to know, for example, whether the number of hours students devote for studies is somehow related to their family income, to age, to sex or to similar other factor. There are several methods of determining the relationship between variables, but no method can tell us for certain that a correlation is indicative of causal relationship. Thus we have to answer two types of questions in bivariate or multivariate populations viz.,

(i) Does there exist association or correlation between the two (or more) variables? If yes, of what degree?

(ii) Is there any cause and effect relationship between the two variables in case of the bivariate population or between one variable on one side and two or more variables on the other side in case of multivariate population? If yes, of what degree and in which direction?

The first question is answered by the use of correlation technique and the second question by the technique of regression. There are several methods of applying the two techniques, but the important ones are as under:

In case of bivariate population: Correlation can be studied through (a) cross tabulation; (b) Charles Spearman's coefficient of correlation; (c) Karl Pearson's coefficient of correlation; whereas cause and effect relationship can be studied through simple regression equations.

In case of multivariate population: Correlation can be studied through (a) coefficient of multiple correlation; (b) coefficient of partial correlation; whereas cause and effect relationship can be studied through multiple regression equations.

We can now briefly take up the above methods one by one.

Cross tabulation approach is specially useful when the data are in nominal form. Under it we classify each variable into two or more categories and then cross classify the variables in these sub-categories. Then we look for interactions between them which may be symmetrical, reciprocal or asymmetrical. A symmetrical relationship is one in which the two variables vary together, but we assume that neither variable is due to the other. A reciprocal relationship exists when the two variables mutually influence or reinforce each other. Asymmetrical relationship is said to exist if one variable (the independent variable) is responsible for another variable (the dependent variable). The cross classification procedure begins with a two-way table which indicates whether there is or there is not an interrelationship between the variables. This sort of analysis can be further elaborated in which case a third factor is introduced into the association through cross-classifying the three variables. By doing so we find conditional relationship in which factor *X* appears to affect factor *Y* only when factor *Z* is held constant. The correlation, if any, found through this approach is not considered a very

powerful form of statistical correlation and accordingly we use some other methods when data happen to be either ordinal or interval or ratio data.

Charles Spearman's coefficient of correlation (*or rank correlation*) is the technique of determining the degree of correlation between two variables in case of ordinal data where ranks are given to the different values of the variables. The main objective of this coefficient is to determine the extent to which the two sets of ranking are similar or dissimilar. This coefficient is determined as under:

$$\text{Spearman's coefficient of correlation (or } r_s) = 1 - \left[\frac{6\sum d_i^2}{n\left(n^2 - 1\right)}\right]$$

where d_i = difference between ranks of ith pair of the two variables;

n = number of pairs of observations.

As rank correlation is a non-parametric technique for measuring relationship between paired observations of two variables when data are in the ranked form, we have dealt with this technique in greater details later on in the book in chapter entitled 'Hypotheses Testing II (Non-parametric tests)'.

Karl Pearson's coefficient of correlation (or simple correlation) is the most widely used method of measuring the degree of relationship between two variables. This coefficient assumes the following:

(i) that there is linear relationship between the two variables;

(ii) that the two variables are casually related which means that one of the variables is independent and the other one is dependent; and

(iii) a large number of independent causes are operating in both variables so as to produce a normal distribution.

Karl Pearson's coefficient of correlation can be worked out thus.

$$\text{Karl Pearson's coefficient of correlation (or } r)^* = \frac{\Sigma\left(X_i - \bar{X}\right)\left(Y_i - \bar{Y}\right)}{n \cdot \sigma_X \cdot \sigma_Y}$$

* Alternatively, the formula can be written as:

$$r = \frac{\Sigma\left(X_i - \bar{X}\right)\left(Y_i - \bar{Y}\right)}{\sqrt{\Sigma\left(X_i - \bar{X}\right)^2 \cdot \Sigma\left(Y_i - \bar{Y}\right)^2}}$$

Or

$$r = \frac{\text{Covariance between } X \text{ and } Y}{\sigma_x \cdot \sigma_y} = \frac{\Sigma\left(X_i - \bar{X}\right)\left(Y_i - \bar{Y}\right)/n}{\sigma_x \cdot \sigma_y}$$

Or

$$r = \frac{\sum X_i Y_i - n \cdot \bar{X} \cdot \bar{Y}}{\sqrt{\sum X_i^2 - n\bar{X}^2}\ \sqrt{\sum Y_i^2 - n\bar{Y}^2}}$$

(This applies when we take zero as the assumed mean for both variables, X and Y.)

where X_i = *i*th value of *X* variable

$\bar{X}$ = mean of *X*

Y_i = *i*th value of *Y* variable

$\bar{Y}$ = Mean of *Y*

n = number of pairs of observations of *X* and *Y*

σ_X = Standard deviation of *X*

σ_Y = Standard deviation of *Y*

In case we use assumed means (A_x and A_y for variables *X* and *Y* respectively) in place of true means, then Karl Person's formula is reduced to:

$$\frac{\frac{\sum dx_i \cdot dy_i}{n} - \left(\frac{\sum dx_i \cdot \sum dy_i}{n}\right)}{\sqrt{\frac{\sum dx_i^2}{n} - \left(\frac{\sum dx_i}{n}\right)^2}\sqrt{\frac{\sum dy_i^2}{n} - \left(\frac{\sum dy_i}{n}\right)^2}}$$

$$\frac{\frac{\sum dx_i \cdot dy_i}{n} - \left(\frac{\sum dx_i \cdot \sum dy_i}{n}\right)}{\sqrt{\frac{\sum dx_i^2}{n} - \left(\frac{\sum dx_i}{n}\right)^2}\sqrt{\frac{\sum dy_i^2}{n} - \left(\frac{\sum dy_i}{n}\right)^2}}$$

where $\sum dx_i = \sum(X_i - A_x)$

$\sum dy_i = \sum(Y_i - A_y)$

$\sum dx_i^2 = \sum(X_i - A_x)^2$

$\sum dy_i^2 = \sum(Y_i - A_y)^2$

$\sum dx_i \cdot dy_i = \sum(X_i - A_x)(Y_i - A_y)$

n = number of pairs of observations of *X* and *Y*.

This is the short cut approach for finding '*r*' in case of ungrouped data. If the data happen to be grouped data (i.e., the case of bivariate frequency distribution), we shall have to write Karl Pearson's coefficient of correlation as under:

$$\frac{\frac{\sum f_{ij} \cdot dx_i \cdot dy_j}{n} - \left(\frac{\sum f_i dx_i}{n} \cdot \frac{\sum f_j dy_j}{n}\right)}{\sqrt{\frac{\sum f_i dx_i^2}{n} - \left(\frac{\sum f_i dx_i}{n}\right)}\sqrt{\frac{\sum f_i dy_j^2}{n} - \left(\frac{\sum f_j dy_j}{n}\right)^2}}$$

where f_{ij} is the frequency of a particular cell in the correlation table and all other values are defined as earlier.

Karl Pearson's coefficient of correlation is also known as the product moment correlation coefficient. The value of '*r*' lies between ± 1. Positive values of *r* indicate positive correlation between the two variables (i.e., changes in both variables take place in the statement direction), whereas negative values of '*r*' indicate negative correlation i.e., changes in the two variables taking place in the opposite directions. A zero value of '*r*' indicates that there is no association between the two variables. When *r* = (+) 1, it indicates perfect positive correlation and when it is (–)1, it indicates perfect negative correlation, meaning thereby that variations in independent variable (*X*) explain 100% of the variations in the dependent variable (*Y*). We can also say that for a unit change in independent variable, if there happens to be a constant change in the dependent variable in the same direction, then correlation will be termed as perfect positive. But if such change occurs in the opposite direction, the correlation will be termed as perfect negative. The value of '*r*' nearer to +1 or –1 indicates high degree of correlation between the two variables.

SIMPLE REGRESSION ANALYSIS

Regression is the determination of a statistical relationship between two or more variables. In simple regression, we have only two variables, one variable (defined as independent) is the cause of the behaviour of another one (defined as dependent variable). Regression can only interpret what exists physically i.e., there must be a physical way in which independent variable *X* can affect dependent variable *Y*. The basic relationship between *X* and *Y* is given by

$$\hat{Y} = a + bX$$

where the symbol $\hat{Y}$ denotes the estimated value of *Y* for a given value of *X*. This equation is known as the regression equation of *Y* on *X* (also represents the regression line of *Y* on *X* when drawn on a graph) which means that each unit change in *X* produces a change of *b* in *Y*, which is positive for direct and negative for inverse relationships.

Then generally used method to find the 'best' fit that a straight line of this kind can give is the least-square method. To use it efficiently, we first determine

$$\sum x_i^2 = \sum X_i^2 - n\bar{X}^2$$

$$\sum y_i^2 = \sum Y_i^2 - n\bar{Y}^2$$

$$\sum x_i y_i = \sum X_i Y_i - n\bar{X} \cdot \bar{Y}$$

Then
$$b = \frac{\sum x_i y_i}{\sum x_i^2}, \; a = \bar{Y} - b\bar{X}$$

These measures define *a* and *b* which will give the best possible fit through the original *X* and *Y* points and the value of *r* can then be worked out as under:

$$r = \frac{b\sqrt{\sum x_i^2}}{\sqrt{\sum y_i^2}}$$

Thus, the regression analysis is a statistical method to deal with the formulation of mathematical model depicting relationship amongst variables which can be used for the purpose of prediction of the values of dependent variable, given the values of the independent variable.

[Alternatively, for fitting a regression equation of the type $\hat{Y} = a + bX$ to the given values of X and Y variables, we can find the values of the two constants viz., a and b by using the following two normal equations:

$$\sum Y_i = na + b\sum X_i$$

$$\sum X_i Y_i = a\sum X_i + b\sum X_i^2$$

and then solving these equations for finding a and b values. Once these values are obtained and have been put in the equation $\hat{Y} = a + bX$, we say that we have fitted the regression equation of Y on X to the given data. In a similar fashion, we can develop the regression equation of X and Y viz., $\hat{X} = a + bX$, presuming Y as an independent variable and X as dependent variable].

MULTIPLE CORRELATION AND REGRESSION

When there are two or more than two independent variables, the analysis concerning relationship is known as multiple correlation and the equation describing such relationship as the multiple regression equation. We here explain multiple correlation and regression taking only two independent variables and one dependent variable (Convenient computer programs exist for dealing with a great number of variables). In this situation the results are interpreted as shown below:

Multiple regression equation assumes the form

$$\hat{Y} = a + b_1X_1 + b_2X_2$$

where X_1 and X_2 are two independent variables and Y being the dependent variable, and the constants a, b_1 and b_2 can be solved by solving the following three normal equations:

$$\sum Y_i = na + b_1\sum X_{1i} + b_2\sum X_{2i}$$

$$\sum X_{1i}Y_i = a\sum X_{1i} + b_1\sum X_{1i}^2 + b_2\sum X_{1i}X_{2i}$$

$$\sum X_{2i}Y_i = a\sum X_{2i} + b_1\sum X_{1i}X_{2i} + b_2\sum X_{2i}^2$$

(It may be noted that the number of normal equations would depend upon the number of independent variables. If there are 2 independent variables, then 3 equations, if there are 3 independent variables then 4 equations and so on, are used.)

In multiple regression analysis, the regression coefficients (viz., b_1 b_2) become less reliable as the degree of correlation between the independent variables (viz., X_1, X_2) increases. If there is a high degree of correlation between independent variables, we have a problem of what is commonly described as the *problem of multicollinearity*. In such a situation we should use only one set of the independent variable to make our estimate. In fact, adding a second variable, say X_2, that is correlated with the first variable, say X_1, distorts the values of the regression coefficients. Nevertheless, the prediction for the dependent variable can be made even when multicollinearity is present, but in such a situation enough care should be taken in selecting the independent variables to estimate a dependent variable so as to ensure that multi-collinearity is reduced to the minimum.

With more than one independent variable, we may make a difference between the collective effect of the two independent variables and the individual effect of each of them taken separately. The collective effect is given by the coefficient of multiple correlation,

$R_{y \cdot x_1 x_2}$ defined as under:

$$R_{y \cdot x_1 x_2} = \sqrt{\frac{b_1 \sum Y_i X_{1i} - n\bar{Y}\,\bar{X}_1 + b_2 \sum Y_i X_{2i} - n\bar{Y}\,\bar{X}_2}{\sum Y_i^2 - n\bar{Y}^2}}$$

Alternatively, we can write

$$R_{y \cdot x_1 x_2} = \sqrt{\frac{b_1 \sum x_{1i} y_i + b_2 \sum x_{2i} y_i}{\sum Y_i^2}}$$

where

$$x_{1i} = (X_{1i} - \bar{X}_1)$$

$$x_{2i} = (X_{2i} - \bar{X}_2)$$

$$y_i = (Y_i - \bar{Y})$$

and b_1 and b_2 are the regression coefficients.

PARTIAL CORRELATION

Partial correlation measures separately the relationship between two variables in such a way that the effects of other related variables are eliminated. In other words, in partial correlation analysis, we aim at measuring the relation between a dependent variable and a particular independent variable by holding all other variables constant. Thus, each partial coefficient of correlation measures the effect of its independent variable on the dependent variable. To obtain it, it is first necessary to compute the simple coefficients of correlation between each set of pairs of variables as stated earlier. In the case of two independent variables, we shall have two partial correlation coefficients denoted $r_{yx_1 \cdot x_2}$ and $r_{yx_2 \cdot x_1}$ which are worked out as under:

$$r_{yx_1 \cdot x_2} = \frac{R^2{}_{y \cdot x_1 x_2} - r^2_{yx_2}}{1 - r^2_{yx_2}}$$

This measures the effort of X_1 on Y, more precisely, that proportion of the variation of Y not explained by X_2 which is explained by X_1. Also,

$$r_{yx_2 \cdot x_1} = \frac{R^2_{y \cdot x_1 x_2} - r^2_{yx_1}}{1 - r^2_{yx_1}}$$

in which X_1 and X_2 are simply interchanged, given the added effect of X_2 on Y.

Alternatively, we can work out the partial correlation coefficients thus:

$$r_{yx_1 \cdot x_2} = \frac{r_{yx_1} - r_{yx_2} \cdot r_{x_1x_2}}{\sqrt{1 - r^2_{yx_2}} \sqrt{1 - r^2_{x_1x_2}}}$$

and

$$r_{yx_2 \cdot x_1} = \frac{r_{yx_2} - r_{yx_1} \cdot r_{x_1x_2}}{\sqrt{1 - r^2_{yx_1}} \sqrt{1 - r^2_{x_1x_2}}}$$

These formulae of the alternative approach are based on simple coefficients of correlation (also known as zero order coefficients since no variable is held constant when simple correlation coefficients are worked out). The partial correlation coefficients are called first order coefficients when one variable is held constant as shown above; they are known as second order coefficients when two variables are held constant and so on.

ASSOCIATION IN CASE OF ATTRIBUTES

When data is collected on the basis of some attribute or attributes, we have statistics commonly termed as statistics of attributes. It is not necessary that the objects may process only one attribute; rather it would be found that the objects possess more than one attribute. In such a situation our interest may remain in knowing whether the attributes are associated with each other or not. For example, among a group of people we may find that some of them are inoculated against small-pox and among the inoculated we may observe that some of them suffered from small-pox after inoculation. The important question which may arise for the observation is regarding the efficiency of inoculation for its popularity will depend upon the immunity which it provides against small-pox. In other words, we may be interested in knowing whether inoculation and immunity from small-pox are associated. Technically, we say that the two attributes are associated if they appear together in a greater number of cases than is to be expected if they are independent and not simply on the basis that they are appearing together in a number of cases as is done in ordinary life.

The association may be positive or negative (negative association is also known as disassociation). If class frequency of *AB*, symbolically written as (*AB*), is greater than the expectation of *AB* being together if they are independent, then we say the two attributes are positively associated; but if the class frequency of *AB* is less than this expectation, the two attributes are said to be negatively associated. In case the class frequency of *AB* is equal to expectation, the two attributes are considered as independent i.e., are said to have no association. It can be put symbolically as shown hereunder:

If $(AB) > \frac{(A)}{N} \times \frac{(B)}{N} \times N$, then *AB* are positively related/associated.

If $(AB) < \frac{(A)}{N} \times \frac{(B)}{N} \times N$, then *AB* are negatively related/associated.

If $(AB) = \frac{(A)}{N} \times \frac{(B)}{N} \times N$, then *AB* are independent i.e., have no association.

Where (*AB*) = frequency of class *AB* and

$\frac{(A)}{N} \times \frac{(B)}{N} \times N$ = Expectation of *AB*, if *A* and *B* are independent, and *N* being the number of items

In order to find out the degree or intensity of association between two or more sets of attributes, we should work out the coefficient of association. Professor Yule's coefficient of association is most popular and is often used for the purpose. It can be mentioned as under:

$$Q_{AB} = \frac{(AB)(ab) - (Ab)(aB)}{(AB)(ab) + (Ab)(aB)}$$

where,

Q_{AB} = Yule's coefficient of association between attributes *A* and *B*.

(*AB*) = Frequency of class *AB* in which *A* and *B* are present.

(*Ab*) = Frequency of class *Ab* in which *A* is present but *B* is absent.

(*aB*) = Frequency of class *aB* in which *A* is absent but *B* is present.

(*ab*) = Frequency of class *ab* in which both *A* and *B* are absent.

The value of this coefficient will be somewhere between +1 and –1. If the attributes are completely associated (perfect positive association) with each other, the coefficient will be +1, and if they are completely disassociated (perfect negative association), the coefficient will be –1. If the attributes are completely independent of each other, the coefficient of association will be 0. The varying degrees of the coefficients of association are to be read and understood according to their positive and negative nature between +1 and –1.

Sometimes the association between two attributes, *A* and *B*, may be regarded as unwarranted when we find that the observed association between *A* and *B* is due to the association of both *A* and *B* with another attribute *C*. For example, we may observe positive association between inoculation and exemption for small-pox, but such association may be the result of the fact that there is positive association between inoculation and richer section of society and also that there is positive association between exemption from small-pox and richer section of society. The sort of association between *A* and *B* in the population of *C* is described as *partial association* as distinguished from *total association* between *A* and *B* in the overall universe. We can workout the coefficient of partial association between *A* and *B* in the population of *C* by just modifying the above stated formula for finding association between *A* and *B* as shown below:

$$Q_{AB.C} = \frac{(ABC)(abC) - (AbC)(aBC)}{(ABC)(abC) + (AbC)(aBC)}$$

where,

$Q_{AB.C}$ = Coefficient of partial association between *A* and *B* in the population of *C*; and all other values are the class frequencies of the respective classes (*A*, *B*, *C* denotes the presence of concerning attributes and *a*, *b*, *c* denotes the absence of concerning attributes).

At times, we may come across cases of *illusory association*, wherein association between two attributes does not correspond to any real relationship. This sort of association may be the result of

some attribute, say *C* with which attributes *A* and *B* are associated (but in reality there is no association between *A* and *B*). Such association may also be the result of the fact that the attributes *A* and *B* might not have been properly defined or might not have been correctly recorded. Researcher must remain alert and must not conclude association between *A* and *B* when in fact there is no such association in reality.

In order to judge the significance of association between two attributes, we make use of *Chi-square test*[*] by finding the value of Chi-square (χ_2) and using Chi-square distribution the value of χ_2 can be worked out as under:

$$\chi^2 = \Sigma \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \qquad i = 1, 2, 3 \ldots$$

where $j = 1, 2, 3 \ldots$

O_{ij} = observed frequencies

E_{ij} = expected frequencies.

Association between two attributes in case of manifold classification and the resulting contingency table can be studied as explained below:

We can have manifold classification of the two attributes in which case each of the two attributes are first observed and then each one is classified into two or more subclasses, resulting into what is called as contingency table. The following is an example of 4 × 4 contingency table with two attributes *A* and *B*, each one of which has been further classified into four sub-categories.

Table 7.2: 4 × 4 Contingency Table

		Attribute A				
		A_1	A_2	A_3	A_4	Total
	B_1	$(A_1 B_1)$	$(A_2 B_1)$	$(A_3 B_1)$	$(A_4 B_1)$	(B_1)
Attribute B	B_2	$(A_1 B_2)$	$(A_2 B_2)$	$(A_3 B_2)$	$(A_4 B_2)$	(B_2)
	B_3	$(A_1 B_3)$	$(A_2 B_3)$	$(A_3 B_3)$	$(A_4 B_3)$	(B_3)
	B_4	$(A_1 B_4)$	$(A_2 B_4)$	$(A_3 B_4)$	$(A_4 B_4)$	(B_4)
	Total	(A_1)	(A_2)	(A_3)	(A_4)	N

Association can be studied in a contingency table through Yule's coefficient of association as stated above, but for this purpose we have to reduce the contingency table into 2 × 2 table by combining some classes. For instance, if we combine $(A_1) + (A_2)$ to form (A) and $(A_3) + (A_4)$ to form (a) and similarly if we combine $(B_1) + (B_2)$ to form (B) and $(B_3) + (B_4)$ to form (b) in the above contingency table, then we can write the table in the form of a 2 × 2 table as shown in Table 4.3

[*] See Chapter "Chi-square test" for all details.

Table 7.3

Attribute		*Attribute*		
		A	*a*	Total
	B	(*AB*)	(*aB*)	(*B*)
	b	(*Ab*)	(*ab*)	(*b*)
	Total	(*A*)	(*a*)	*N*

After reducing a contingency table in a two-by-two table through the process of combining some classes, we can work out the association as explained above. But the practice of combining classes is not considered very correct and at times it is inconvenient also, Karl Pearson has suggested a measure known as *Coefficient of mean square contingency* for studying association in contingency tables. This can be obtained as under:

$$C = \sqrt{\frac{\chi^2}{\chi^2 + N}}$$

where

C = Coefficient of contingency

χ^2 = Chi-square value which is $= \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$

N = number of items.

This is considered a satisfactory measure of studying association in contingency tables.

OTHER MEASURES

1. Index numbers: When series are expressed in same units, we can use averages for the purpose of comparison, but when the units in which two or more series are expressed happen to be different, statistical averages cannot be used to compare them. In such situations we have to rely upon some relative measurement which consists in reducing the figures to a common base. Once such method is to convert the series into a series of index numbers. This is done when we express the given figures as percentages of some specific figure on a certain data. We can, thus, define an index number as a number which is used to measure the level of a given phenomenon as compared to the level of the same phenomenon at some standard date. The use of index number weights more as a special type of average, meant to study the changes in the effect of such factors which are incapable of being measured directly. But one must always remember that index numbers measure only the relative changes.

Changes in various economic and social phenomena can be measured and compared through index numbers. Different indices serve different purposes. Specific commodity indices are to serve as a measure of changes in the phenomenon of that commodity only. Index numbers may measure cost of living of different classes of people. In economic sphere, index numbers are often termed as

'economic barometers measuring the economic phenomenon in all its aspects either directly by measuring the same phenomenon or indirectly by measuring something else which reflects upon the main phenomenon.

But index numbers have their own limitations with which researcher must always keep himself aware. For instance, index numbers are only approximate indicators and as such give only a fair idea of changes but cannot give an accurate idea. Chances of error also remain at one point or the other while constructing an index number but this does not diminish the utility of index numbers for they still can indicate the trend of the phenomenon being measured. However, to avoid fallacious conclusions, index numbers prepared for one purpose should not be used for other purposes or for the same purpose at other places.

2. Time series analysis: In the context of economic and business researches, we may obtain quite often data relating to some time period concerning a given phenomenon. Such data is labelled as 'Time Series'. More clearly it can be stated that series of successive observations of the given phenomenon over a period of time are referred to as time series. Such series are usually the result of the effects of one or more of the following factors:

(i) *Secular trend* or long term trend that shows the direction of the series in a long period of time. The effect of trend (whether it happens to be a growth factor or a decline factor) is gradual, but extends more or less consistently throughout the entire period of time under consideration. Sometimes, secular trend is simply stated as trend (or T).

(ii) *Short time oscillations* i.e., changes taking place in the short period of time only and such changes can be the effect of the following factors:

(a) *Cyclical fluctuations* (*or C*) are the fluctuations as a result of business cycles and are generally referred to as long term movements that represent consistently recurring rises and declines in an activity.

(b) *Seasonal fluctuations* (*or S*) are of short duration occurring in a regular sequence at specific intervals of time. Such fluctuations are the result of changing seasons. Usually these fluctuations involve patterns of change within a year that tend to be repeated from year to year. Cyclical fluctuations and seasonal fluctuations taken together constitute short-period regular fluctuations.

(c) *Irregular fluctuations* (*or I*), also known as Random fluctuations, are variations which take place in a completely unpredictable fashion.

All these factors stated above are termed as components of time series and when we try to analyse time series, we try to isolate and measure the effects of various types of these factors on a series. To study the effect of one type of factor, the other type of factor is eliminated from the series. The given series is, thus, left with the effects of one type of factor only.

For analysing time series, we usually have two models; (1) multiplicative model; and (2) additive model. Multiplicative model assumes that the various components interact in a multiplicative manner to produce the given values of the overall time series and can be stated as under:

$$Y = T \times C \times S \times I$$

where

Y = observed values of time series, T = Trend, C = Cyclical fluctuations, S = Seasonal fluctuations, I = Irregular fluctuations.

Additive model considers the total of various components resulting in the given values of the overall time series and can be stated as:

$$Y = T + C + S + I$$

There are various methods of isolating trend from the given series viz., the free hand method, semi-average method, method of moving averages, method of least squares and similarly there are methods of measuring cyclical and seasonal variations and whatever variations are left over are considered as random or irregular fluctuations.

The analysis of time series is done to understand the dynamic conditions for achieving the short-term and long-term goals of business firm(s). The past trends can be used to evaluate the success or failure of management policy or policies practiced hitherto. On the basis of past trends, the future patterns can be predicted and policy or policies may accordingly be formulated. We can as well study properly the effects of factors causing changes in the short period of time only, once we have eliminated the effects of trend. By studying cyclical variations, we can keep in view the impact of cyclical changes while formulating various policies to make them as realistic as possible. The knowledge of seasonal variations will be of great help to us in taking decisions regarding inventory, production, purchases and sales policies so as to optimize working results. Thus, analysis of time series is important in context of long term as well as short term forecasting and is considered a very powerful tool in the hands of business analysts and researchers.

Questions

1. "Processing of data implies editing, coding, classification and tabulation". Describe in brief these four operations pointing out the significance of each in context of research study.
2. Classification according to class intervals involves three main problems viz., how many classes should be there? How to choose class limits? How to determine class frequency? State how these problems should be tackled by a researcher.
3. Why tabulation is considered essential in a research study? Narrate the characteristics of a good table.
4. (a) How the problem of DK responses should be dealt with by a researcher? Explain.
   (b) What points one should observe while using percentages in research studies?
5. Write a brief note on different types of analysis of data pointing out the significance of each.
6. What do you mean by multivariate analysis? Explain how it differs from bivariate analysis.
7. How will you differentiate between descriptive statistics and inferential statistics? Describe the important statistical measures often used to summarise the survey/research data.
8. What does a measure of central tendency indicate? Describe the important measures of central tendency pointing out the situation when one measure is considered relatively appropriate in comparison to other measures.
9. Describe the various measures of relationships often used in context of research studies. Explain the meaning of the following correlation coefficients:

   (i) r_{yx}, (ii) $r_{yx_1 \cdot x_2}$, (iii) $R_{y \cdot x_1 x_2}$
10. Write short notes on the following:
    (i) Cross tabulation;
    (ii) Discriminant analysis;

(iii) Coefficient of contingency;
(iv) Multicollinearity;
(v) Partial association between two attributes.

11. "The analysis of time series is done to understand the dynamic conditions for achieving the short-term and long-term goals of business firms." Discuss.

12. "Changes in various economic and social phenomena can be measured and compared through index numbers". Explain this statement pointing out the utility of index numbers.

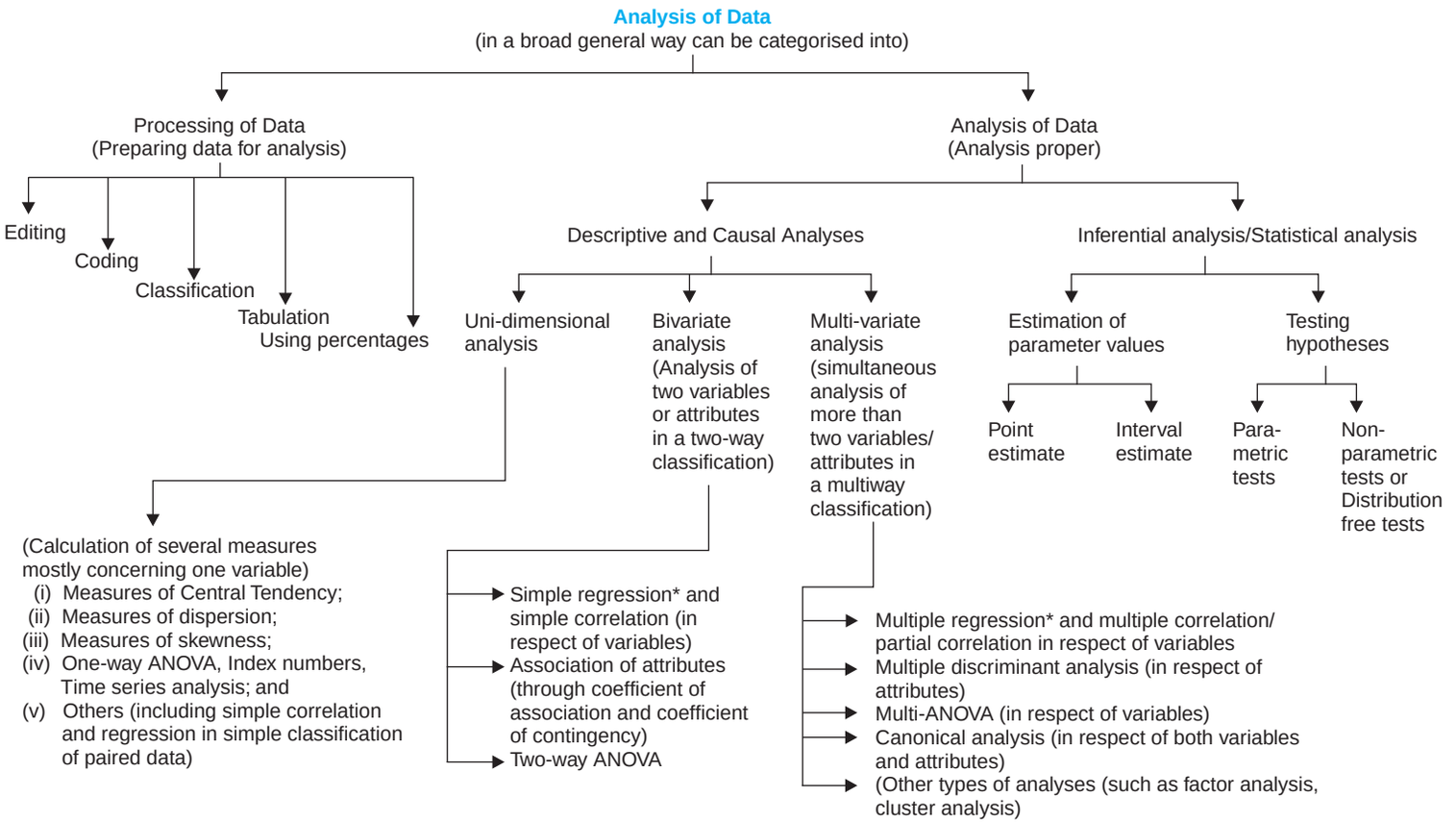
13. Distinguish between:
(i) Field editing and central editing;
(ii) Statistics of attributes and statistics of variables;
(iii) Exclusive type and inclusive type class intervals;
(iv) Simple and complex tabulation;
(v) Mechanical tabulation and cross tabulation.

14. "Discriminate use of average is very essential for sound statistical analysis". Why? Answer giving examples.

15. Explain how would you work out the following statistical measures often used by researchers?
(i) Coefficient of variation;
(ii) Arithmetic average;
(iii) Coefficient of skewness;
(iv) Regression equation of X on Y;
(v) Coefficient of $r_{yx_2 \cdot x_1}$.

Appendix

(Summary chart concerning analysis of data)



* Regression analysis (whether simple or multiple) is termed as Causal analysis whereas correlation analysis indicates simply co-variation between two or more variables.