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and unknown gadgets recording their conversation. The setting should be informal, with as less intrusive instruments used. The moderators need to be friendly and not serious academics. The group should first be made comfortable before the discussion and question-answer session may start.

- Guarantee of confidentiality is a must before a focus group can be used. The participants may warm up to each other on knowing that they would generally not meet again and that what is being said would not leave the room or be used by the researcher in any other situation other than the one announced. The researcher needs to ethical enough to maintain what he had guaranteed the participants.

However, many major brands have bore the brunt of introducing focus groups in their research. Coca-Cola, in the 1980s, had tried unsuccessfully to launch a new flavour. Apparently, the focus group that was used for this liked the new flavour. However, the market did not accept the flavour launched with much fanfare and the company had to endure a huge loss. Jonathan Ive, Apple's Senior Vice President of industrial design, also said that Apple had found a good reason not to do focus groups: 'They just ensure that you don't offend anyone, and produce bland, inoffensive products.'

2.4.5 Case Study

Case studies are discussions of individual cases under topics of discussion which help researchers to corroborate known facts proved previously through research. Social scientists, in particular, used the case study method to research for many years. A variety of disciplines used this method of research to corroborate their findings in real life situations. Researcher Robert K. Yin defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (Yin, 1984, p. 23).

However, critics feel that the case study method is not reliable enough for establishing a rule or principle as it portrays only a minuscule population which forms not even a part of the entire population. Some feel that this method is only a reliable exploratory tool. Literature supports reports of carefully planned and crafted studies of the case study method. Robert E. Stake, Helen Simmons, and Robert Yin are renowned researchers who have written about the utility of case studies in social sciences. They have prescribed six steps that should be used when utilizing the case study method. These are:

- Determine and define the research questions
- Select the cases and determine data gathering and analysis techniques

- Prepare to collect the data
- Collect data in the field
- Evaluate and analyse the data
- Prepare the report

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1. Determine and define the research questions

Before a case study research is undertaken, cementing a research focus is important so that the researcher can refer to it during the course of study. The research object is often a person, an organizational policy, a group of people, etc. A number of data gathering methods are used by the researcher who studies every case study in depth. The researcher reads the available literature to understand where the topic stands in terms of prior research and undertakes a thorough planning before embarking on the actual case study. Literature and previous study help him to decide where to look for evidence to corroborate his findings on the concerned topic. These help in designing the blueprint for the current study.

2. Select the cases and determine data gathering and analysis techniques

While designing the study, the researcher finalizes the approaches, methods of data extraction and data gathering for real-life cases he needs to study. While using multiple cases, each case is treated as a single case. The conclusions of these cases can then be utilized for underlining various facets of his study. The researcher needs to discriminate positively for the case study that he means to utilize for corroborating his findings. The researcher should decide whether he wants to study cases that are conventional or extraordinary while conducting the study. In case he is hesitant, he may go back to the purpose of the study that he had enumerated before beginning the research. The decision to choose a single or multiple case studies is an important one, while a single case study may be examined for analysing more than one inherent principle. These types of case studies involve two different levels of analysis which increases the complexity of data collected. Multiple sources and techniques in the data collecting process is a key strength of the case study method. The researcher needs to determine what data he would wish to gather by examining a case and how to analyse the data collected. The tools he may use are interviews, surveys, documentation review, observation and collection of physical artifacts. During the design phase of the research, the researcher should make sure that the study ensures construct validity, external validity, internal validity and reliability. The researcher needs to use the correct measures for ensuring construct validity. Internal validity is ensured when the conditions may be used over and over again to prove validity of the case. External validity is ensured when the findings may be generalized beyond the case or cases. A case study is said to be more externally valid when it can withstand more people, places and procedures. Techniques

known as within-case examination and cross-case examination and literature review help ensure the validity of the case.

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3. **Prepare to collect the data**

Researchers using case study method generally gather a large amount of data from a number of sources. Organizing this data in a systematic manner is a challenge in itself. The researcher should plan ahead to prevent getting overwhelmed by this data. He might even lose sight of the original purpose of gathering the data. Researchers sort, categorize, store and retrieve data for analysis with the help of databases. Extraordinary cases help the researcher by providing an efficient training programme, establishing proper protocols and conducting a pilot study before entering into fieldwork. The training programme covers the concept to be studied, terminology, processes, methods, etc. The researchers also learn the application of techniques used in the study. In order to gather data from the interviewed population, the researcher has to be skilled enough to retain or record the interviews without the gadget coming in the interviewee's way. The researcher should know how to steer conversation towards the questions he intends to ask next. He should be trained in analysing body language and interpret answers not expected by him. He needs to read between the lines and in case the topic is sensitive, understand a respondent's hesitation and silence. The researcher should not feel threatened by missed appointments and lack of space for holding the interview or unexpected turns of events during the interview; for example, a respondent may break down while answering a sensitive question. The researcher should be humane, understanding and flexible in approach. He should revisit the research design that he had created before starting the case studies and make changes as and when required.

4. **Collect data in the field**

The researcher should be trained to collect and store multiple sources of evidence in various formats while going about studying the case. Though case study research is flexible, any change that comes up in a case study needs to be documented carefully. The multiple storing of data is required so that converging lines of enquiry and patterns may be discovered. Field notes may be used for recording intuitions, hunches, feelings, and also for documenting the work in progress. Illustrations, anecdotes and special records may be written in the field notes so that the researcher may refer to it when making case study reports. The data and the field notes should be kept separately for analysis. The researcher needs to document, classify and cross-reference all evidence so that these could be efficiently recalled for examination and sorting as and when required.

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5. **Evaluate and analyse the data**

The raw data gathered by the researcher needs to be interpreted at different levels to find linkages between the objectives of the research and the outcome of studying the case. He must remain open to new insights and opportunities throughout the evaluation and analysis process. The researcher can triangulate data with the help of different techniques and collection methods inherent to the case study method. Researchers will be provided with new insights and conflicting data by case studies which are extraordinary. They would need to categorize, tabulate and combine data to address the purpose of the study. In order to cross-check data collected, short, repeat interviews need to be conducted. Placing information into arrays, creating matrices of categories, making flow charts or other displays, etc., may be used by the researcher as specific techniques. The quantitative data collected may be used to corroborate the qualitative data collected during interviews. Many research organizations may also use multiple researchers to verify the data collected. When these multiple observations converge, researchers may become more confident of their findings. Conflicting observations need in-depth study of the findings again. The cross-case search technique requires that researchers look at data from different angles and do not reach a premature conclusion. Across all cases investigated, the cross-case search divide data by type. When a pattern from one data is vouched for by another data, the finding is stronger. When these evidences do not form a data, a further probe is essential.

6. **Prepare the report**

An exemplary case study report transforms the manner in which a complex issue is presented. Case study reports are often published so that readers may apply the experience in his or her real-life situations. The case studies mostly display evidences to gain the reader's confidence. Researchers also underline the boundaries of the case and draw reader attention to conflicting propositions. Many researchers present case study reports in form of a chronological account. Some may treat a case as-fresh chapter. Once a report is completed, the researcher should always edit and examine it for loopholes. Representative audience group is used for comments and criticisms and the valid criticisms are incorporated in the next draft. Since case studies involve multiple sources of data, or may include more than one case within a study, they often become complex. The case study method is generally used by researchers from various disciplines to build upon a theory, to produce a new theory, to challenge or dispute a theory, to explore new horizons, to apply solutions to situations, to describe a phenomenon, etc. There are a number of advantages of the case-study method. These are: applicability to real life situations, to contemporary social situations and easy accessibility to its published reports. Case studies help common man understand a complex theory through easy, real-life situations that are used to exemplify the principle being discussed.

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CHECK YOUR PROGRESS

6. What are the three roles of observation?
7. According to Guthrie, what are the main ways of improving validity?
8. What is a semi-structured interview?
9. List three advantages of a questionnaire.
10. What is a focus group?

2.5 MEASUREMENT AND SCALING TECHNIQUES

The importance of data, be it in governance, business, social research or day-to-day life requires hardly any overemphasis. If scientifically collected, it aids decision-making even in uncertain environments.

We constantly encounter data from time to time but in order to appreciate it, we must know the scales of measurement. For instance, 5 and 6 could be ordinary numbers or they could refer to heights in feet or weight in kilograms. If the data are of a particular type, it enables further mathematical treatment while certain types of data are not so. For instance, if the above two numbers refer to people in a class ranked in terms of their honesty, taking an average of these numbers does not make any sense for obvious reasons. Thus, it is essential to understand scales of measurement for an appropriate and meaningful use of statistical tools and techniques, based on different scales of measurement. The four commonly used scales of data measurement are:

1. Nominal scale
2. Ordinal scale
3. Interval scale
4. Ratio scale

Nominal and ordinal scale data measurements are normally used for imprecise measurements, viz., demographic questions, ranking of items under the study, etc., and are termed as 'categorical' data. On the other hand, interval and ratio scale are grouped together as continuous data. The above scales of measurement follow a hierarchy of measurement scales, with nominal being at the lowest rung of the hierarchy.

Nominal data having unordered scales are called nominal scales, viz., the gender categories: male and female. Categorical data having ordered scales are called ordinal scale. In the case of continuous data, scales relating to interval data are called interval scales and data having both equal intervals and an absolute zero point are called ratio scales.

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1. Nominal scale

The values of the nominal data have no numeric meaning and no further mathematical operation is possible on them except counting. They are in fact used in classifying whether the individual items belong to some distinctively different categories. Nominal scale is used in case data refers to a code given to describe the attribute of an element; for example, in case of a particular socio-economic survey, we give '1' for general candidates, '2' for those belonging to Scheduled Castes, '3' for those belonging to Scheduled Tribes and '4' for those belonging to Other Backward Castes. We have in practice quantitative data comprising numbers but it is essential to recognize that the scale of measurement here is nominal. Unique Identification Number, voter identity card number, ration card number, employee number, PAN card number, Provident Fund account number are some more examples of nominal data. Apart from counting, no other mathematical operation can be carried out on these variables. This level of measurement which does not signify much is the lowest level of measurement.

2. Ordinal scale

The ordinal scale is used to rank or order objects; for instance, in a socio-economic survey, if a response to a question has five options and numerical values are associated with each option as follows:

No opinion [0], strongly disagree [1], disagree [2], agree [3] and strongly agree [4].

In this case of ordinal scale of measurement, we cannot make a claim that the interval between ranks 1 and 2 is same as that of 3 and 4. The exact difference between the above numerical values cannot be measured. In other words, let us say that 5 per cent of people expressed no opinion, 10 per cent of people interviewed expressed an opinion 'strongly disagree' while 25 per cent disagreed. 50 per cent agreed while 10 per cent stated that they strongly agree. Researchers cannot say that difference between 'agree' and 'strongly disagree' is same as that of 'no opinion' and 'strongly disagree'. Though in the case of ordinal variable, we can specify that higher order items represent more quality represented by the variable, we cannot still tell how much more than the other item. In this category, we can only say that certain mathematical assertions such as greater than or less than are possible and for this reason, only median and range can be calculated for ordinal data.

3. Interval scale

In the interval scale, the difference between two consecutive numbers is meaningful. Interval data is numeric and lends itself to further mathematical treatment; for instance, if students have scored 10,40,60,85 in social research paper, we can compute the range, i.e., difference between highest mark and the lowest mark, which gives us an idea about the spread of data and can

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enable us to draw meaningful conclusions. Difference between consecutive ranking points is also important. We can not only rank different items but also quantify the size of difference between them. For instance, take temperature as measured in Celsius. We can say that 40^0 celsius is higher than 20^0celsius but we cannot make a claim that the former is twice as warm as the latter.

4. Ratio scale

Ratio level measurements possess all the properties of interval data with meaningful ratio of two values. For instance, if a company produces two pens priced ₹ 25 and 50, it can be said that the price of second product is twice that of the first one. Ratio variables measured by scale not only have equidistant points, but also have a rational zero. Therefore, in addition to all the properties of interval variables, they feature an identifiable absolute zero point.

Interval and ratio level data are collected using some precise instruments. These data are called metric data and are sometimes referred to as quantitative data (Bajpai, 2010:4). Most of the variables we measure in field situations conform to ratio scale properties, though most statistical data analysis procedures do not distinguish between the interval and ratio properties of the measurement scales (Kultar Singh, 2007).

Nominal data has the most limited use in terms of the use of analytical statistical tools and techniques. As compared to nominal data, ordinal data allows a researcher to use statistical tools and techniques with some additional features. Interval level data measurement has some additional properties over nominal and ordinal level data. One can make ratio comparison with the help of ratio level data and in addition, statistical analysis can be performed. When we keep their usage in view, nominal, ordinal, interval and ratio level data can be placed in increasing order or ascending order with the nominal data being the weakest and ratio data being the strongest in terms of applicability in different statistical tests.

In terms of using data level, statistical tools and techniques can be divided into *non-parametric* and *parametric statistics*. Nominal and ordinal level data can be analysed using non-parametric statistics while interval and ratio level data can be analysed using parametric statistics.

SPSS package enables a researcher to conduct non-parametric statistical tests. One can run tests such as Run test, Mann-Whitney U-test, Wilcoxon Matched-Paired Signed test, Kruskal-Wallis test, Friedman test and Spearman's Rank Correlation are some examples of the non-parametric tests.

Attitudinal scales are composite scales which try to bring objectivity into subjective concepts of aptitude and attitude. They measure underlying traits and behaviours such as trust, joy, patience, happiness, or verbal ability.

Attitudinal scales are therefore also defined as measures that try to quantify abstract and subjective behaviour and attitude.

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Check Your Progress

11. What is the importance of data?
12. What are the four scales of data measurement?
13. What does a SPSS package enable?

2.6 RELIABILITY AND VALIDITY SCALES

In terms of statistical adequacy, indicators can be assessed for their reliability and validity. Reliability of an indicator refers to consistency in the estimate or the value of an indicator if the data-generating mechanism employed for devising an indicator is repeated. Moreover, reliability of an indicator is affected by biases in data-generating mechanisms, which, inter-alia, could be the result of wrong specification of questions or definitions, apprehensions of the respondents and non-representativeness of the sample. The notion of validity refers to the truthfulness of information provided by the estimate or the value of an indicator. In other words, the criterion of validity requires an indicator to effectively measure what it is supposed to measure. The other statistical indicators that are also considered for assessment of the initiatives include availability and periodicity of data; disaggregation and decomposability of data; amenability to use in international comparisons; and transparency of the methodology.

All the above-mentioned requirements are indeed vital if meaningful conclusions are to be drawn from the use of indicators.

Reliability

Reliability signifies the issue of consistency of measures, that is, the ability of a measuring instrument to measure the same thing each time it is used. The following are three important factors in assessing reliability (Kultar Singh, 2007):

1. Stability: It involves asking whether a measure is stable over time so that researchers can be confident that results relating to the measure for a sample of respondents will not fluctuate.
2. Internal reliability: It seeks to assess whether the indicators that make up the scale or index are consistent.
3. Inter-observer consistency: It may arise due to the involvement of more than one observer in activities such as recording of observation or translation of data into categories.

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Validity

It tries to assess whether a measure of a concept really measures that concept, i.e., the extent to which the concept measures the thing it was designed to measure. When we have whole price index (WPI), does it really measure the increase in inflation? Here when questions are raised about the use of WPI as an accurate measure of inflation, the measurement validity of WPI in relation to inflation is being doubted. While intelligence tests (IQ measurement tests) may have a high reliability, they might have low validity with respect to job performance. It is therefore imperative that in order for a research study to be accurate, its findings must be both reliable and valid.

What then is the relation between these two concepts — reliability and validity? Though they are different concept yet, they are related in some way. Validity presumes reliability and therefore if a measure is not reliable, it cannot be valid, though the opposite may not hold true. A study can be reliable even if it is not valid. The factors which go against reliability and validity of data can be overcome if internal validity can be ensured by adopting the most appropriate research design for the study. (Kultar Singh: 2007).

2.6.1 Methods of Measuring Reliability

There are several methods for measuring reliability, some of which are given below:

Test-retest technique

Test-retest technique is generally used to administer the same research instrument/ test/ survey or measure to the same group of people twice under the same conditions but at different points in time. Reliability estimates are expressed in the form of a correlation coefficient, which is a measure of the correlation between two scores in the same group.

Multiple forms

Multiple forms are also known by other names such as parallel forms and disguised test-retest. It tests the reliability of the research instrument by mixing up the questions in the research instrument and giving it to the same respondents again to assess whether it results in any different responses.

Inter-rater reliability

Inter-rater reliability is used to assess the reliability of research tool instruments/tests when more than one rater/interviewer is involved in interviewing or content analysis. It is calculated by reporting the percentage of agreement on the same subject between different raters or interviewers.

Split-half reliability

In the case of split-half reliability method, half of the indicators, tests, instruments, or surveys, are analyzed assuming it to be the whole thing. Then,

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the results of the analysis are compared with the overall analysis, to assess the reliability of the indicators, tests or instruments.

Cronbach's alpha and Kuder-Richardson coefficient are used to test internal reliability nowadays using statistical packages like SPSS. Cronbach's alpha is a commonly used test of internal reliability. It calculates the average of all possible split-half reliability coefficients and a computed alpha coefficient which varies between 0 and 1. Score of 1 indicates perfect internal reliability while a score of 0 denotes no internal reliability and a value of 0.75 or more is usually regarded as an accepted level of reliability. (Kultar Singh: 2007).

2.6.2 Methods of Measuring Validity

There are two types of validity, external and internal validity, both of which should be kept in view by researchers. External validity refers to the extent to which a research study can be generalized to other situations. On the other hand, internal validity relates to the true causes, which result in a outcome. In other words, it signifies the:

1. Rigour with which the study was conducted, and
2. Extent to which the designers of a study have taken into account alternative explanations for any causal relationships they explore.

Internal validity in turn can be further subdivided into the following four broad sub-categories:

1. **Face validity**

   It refers to validity that establishes the fact that the measure apparently reflects the content of the concept in question. Face validity is established by asking other people whether the measure seems to capture the concept that is the focus of attention. It is essentially an assertion on the part of the researchers that they have reasonably measured the concept they intended to measure.

2. **Content validity**

   It tries to assess whether the content of the measurement technique is in conformity with the existing literature on the topic. If the researcher has concentrated only on some dimensions of a construct or concept, then one can assert that other indicators were overlooked and the study therefore lacks content validity. It can easily be estimated from a review of the literature on the concept/construct topic or through consultation with experts in the field. Thus, this process of verification of content validity ensures that the researcher has covered all the conceptual space. Thus, it is usually established by content experts.

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3. Criterion validity

It is also known as instrumental validity and draws an inference from test scores about performance that demonstrates the accuracy of a measure or procedure by comparing it with other standard valid procedure.

There are different forms of criterion validity. In concurrent validity, researchers seek to employ a criterion on which cases/subjects are known to differ and assess how well the criterion captures the actual behaviour; in the case of predictive validity, researchers use a future criterion measure to assess how well it estimates future events that have not happened yet.

4. Construct validity

In construct validity, researchers are encouraged to deduce the hypothesis from a theory that is relevant to the concept. Construct validity can be further segmented into two sub-categories: convergent validity and discriminate validity. In the case of convergent validity, validity is gauged by comparing it to measures of the same concept developed through other methods to assess how well the items are together or distinguish different people on certain behaviours. (Kultar Singh, 2007:79).

CHECK YOUR PROGRESS

14. What are the three important factors in assessing reliability?
15. What is validity?
16. List the methods of measuring validity.

2.7 SUMMARY

- It is possible to estimate population characteristics based on a small sample drawn from it on a scientific basis and using rigorous statistical methodology. The sampling method has several advantages over complete enumeration or census. They include reduced cost, greater speed, greater accuracy and greater scope.
- Sample surveys are used for a wide variety of purposes including planning as in statecraft, market research, business, scientific research etc. Statistical quality control uses sampling techniques extensively.
- There are two ways of selecting a sample: random selection and purposive selection. Random selection is an illustration of probability

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sampling in which each unit in the population had an equal chance of being included in the sample. In this case, the use of sampling theory and normal distribution enable the sampler to predict from sample data, the amount of error to be expected in the estimates made from the sample. In contrast, purposive selection amounts non-probability sampling. In purposive sampling, researcher's subjectivity comes in and chance factor is given a go-by. On the basis of selection procedure used, random and non-random sampling techniques are referred as probability and non-probability sampling.

- Though sampling is undertaken for many purposes, the following four characteristics of population are of great interest:
  - (i) Mean = $\bar{Y}$ [e.g., the average age of all legislators in the country]
  - (ii) Total = Y [e.g., the total number of acres under rice cultivation in a State]
  - (iii) Ratio of two totals or means $R = \frac{Y}{X} = \frac{\bar{Y}}{\bar{X}}$ [e.g., ratio of boys and girls undergoing schooling in a city]
  - (iv) Proportion of units that fall into some defined class [e.g., proportion of people with disabilities in a State]
- Sampling theory is concerned with estimation of the above four characteristics of the population. The symbol ^ denotes an estimate of a population characteristic made from a sample.
- In simple random sampling each member of the population has an equal chance of being included in the sample. Simple random sampling is a method of selecting 'n' units out of the N such that every one of the distinct samples has an equal chance of being drawn. In practice, a simple random sample is drawn unit by unit.
- Stratified sampling involves dividing entire population into several strata and thereafter from each strata, a sample is drawn, the drawings being made independently in different strata. If a simple random sample is taken in each stratum, the whole procedure is described as stratified random sampling. Stratification is a common technique on account of several reasons. It may produce a gain in precision in the estimates of characteristics of the whole population.
- In cluster sampling, we divide the population into non-overlapping areas or clusters. Unlike stratified sampling where strata are homogeneous, in cluster sampling, clusters are internally heterogeneous. A cluster contains a wide range of elements that are good representatives of the population.
- Systematic sampling: suppose there are N units in the population that are numbered between 1 to N in some order. To select a sample of n

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units, we take a unit at random from first k units and every kth unit thereafter. For instance if k = 15 and if the first unit drawn is number 6, the subsequent units are 21, 36, 51,... and so on. In other words, the selection of first unit i.e 6 determines the whole sample. This type is called every kth sample. In the process of a multi-stage sampling, first, a sample is taken from the primary stage units and then a sample is taken from the secondary stage units

- At every stage of research, say, collection, tabulation, analysis and interpretation of data, errors can creep into the process. In statistical theory, they have been studied and classified into sampling and non-sampling errors. If the sample is not a true representative of the population, it gives rise to sampling errors. On the other hand, in a census or complete enumeration there are no sampling errors as we do not take a sample but do a 100 per cent enumeration.
- Non-sampling errors mainly arise at the stage of observation, ascertainment of responses to questionnaire and processing of data.
- Observation is a data collection technique in which there are two main distinct ways. Ethnography makes use of extended periods of observation in natural settings to learn in detail about particular cultures and the meaning of those cultures to their members. On the other hand, structured observation makes use of observation schedules in formal settings.
- Interviewing is a common method of data collection in social sciences. There are three types of interviews: Unstructured interviews; semi-structured interviews; structured interviews.
- The values of the nominal data have no numeric meaning and no further mathematical operation is possible on them except counting. They are in fact used in classifying whether the individual items belong to some distinctively different categories. The ordinal scale is used to rank or order objects. Though in the case of ordinal variable, we can specify that higher order items represent more quality represented by the variable, we cannot still tell how much more than the other item. In ordinal scale category, we can only say that certain mathematical assertions such as greater than or less than are possible and for this reason, only median and range can be calculated for ordinal data.
- In the case of interval scale, we can not only rank different items but also quantify the size of difference between them. Ratio level measurements possess all the properties of interval data with meaningful ratio of two values. Nominal and ordinal level data can be analyzed using non-parametric statistics while interval and ratio level data can be analysed using parametric statistics.

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- Reliability signifies the issue of consistency of measures, that is, the ability of a measuring instrument to measure the same thing each time it is used.
- There are several methods for measuring reliability. Cronbach's alpha and Kuder-Richardson coefficient are used to test internal reliability nowadays using statistical packages like SPSS. Cronbach's alpha is a commonly used test of internal reliability. It calculates the average of all possible split-half reliability coefficients and a computed alpha coefficient which varies between 0 and 1. Score of 1 indicates perfect internal reliability while a score of 0 denotes no internal reliability and a value of 0.75 or more is usually regarded as an accepted level of reliability.
- Validity tries to assess whether a measure of a concept really measures that concept, i.e., the extent to which the concept measures the thing it was designed to measure. External validity refers to the extent to which a research study can be generalized to other situations.

2.8 KEY TERMS

- **Sample:** A smaller group taken from a larger group to use information on the larger group
- **Sampling:** The process of collecting a sample
- **Fieldwork:** Research conducted in the real world rather than within a laboratory
- **Sampling error:** A situation in which a group of figures does not show a true situation as it had been based on data not typical of the wider group

2.9 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Reduced cost, greater speed, greater scope and greater accuracy are the advantages of the sampling method.
2. The principal steps in a sample survey are: defining the objectives of the survey, deciding on the population to be sampled; zeroing on data to be collected; degree of precision desired; methods of measurement; constructing a list of sampling units called the frame; selection of the sample; conducting the pretest; organization of fieldwork; summary and analysis of data and information gained for future surveys.
3. Ya-Lin Chou observes that 'Probability is the science of decision-making with calculated risks in the face of uncertainty.' James Bernoulli gave the following classical definition of probability. According to him,

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"If a random experiment or a trial results in `n' exhaustive mutually exclusive and equally likely outcomes [or cases] out of which `m' are favourable to the occurrence of an event E, then the probability `p' of occurrence [or happening] of E, usually denoted by P[E] is given by

$$p = P[E] = \frac{\text{Number of favourable cases}}{\text{Total Number of Exhausive Cases}} = \frac{m}{n}$$

4. Random sampling methods include:
   - Simple random sampling
   - Stratified sampling
   - Cluster sampling
   - Systematic sampling
   - Multi-stage sampling
5. Some common non-sampling errors are:
   - Faulty designing and planning of survey
   - Response errors
   - Non-response bias
   - Errors in coverage
   - Compiling error and publication error.
6. The three roles of observation are: participant, non-participant and hidden observation.
7. Guthrie (2010:110) states that the main ways of improving validity are:
   - Mixed methods: Ethnographic case studies usually use interviews as well as observation.
   - Triangulation: It involves asking participants to comment on draft material. It can greatly add to understanding of the reasons for their reported behaviour.
8. Guthrie (2010:119) points out that semi-structured interviews use guides so that information from different interviews is directly comparable. These guides provide flexibility to vary the order of intervening questions. There are coded closed-response questions like did you file IT return? Yes/ no. They can be followed up with open-ended questions to get more information. Thus, semi-structured interviews give rise to both quantitative and qualitative data.
9. Advantages of a questionnaire:
   - The data gathered is standardized and therefore, easy to analyse
   - Data can be gathered quickly from a large number of respondents
   - It is possible to compare your results with similar surveys used in other institutions

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10. A focus group is a form of qualitative research in which a group of people are asked about their perceptions, opinions, beliefs and attitudes towards a product, service, concept, advertisement, idea, or packaging. Questions are asked in an interactive group setting where participants are free to talk with other group members. The first focus groups were created at the Bureau of Applied Social Research in the USA, by associate director, sociologist Robert K. Merton. The term itself was coined by psychologist and marketing expert Ernest Dichter.
11. The importance of data, be it in governance, business, social research or day-to-day life requires hardly any overemphasis. If scientifically collected, it aids decision-making even in uncertain environments.
12. The four scales of data measurement used commonly are:
    - Nominal scale
    - Ordinal scale
    - Interval scale
    - Ratio scale
13. SPSS package enables a researcher to conduct non-parametric statistical tests. One can run tests such as Run test, Mann-Whitney U-test, Wilcoxon Matched-Paired Signed test, Kruskal-Wallis test, Friedman test and Spearman's Rank Correlation are some examples of the non-parametric tests.
14. The following are three important factors in assessing reliability (Kultar Singh, 2007):
    - Stability: It involves asking whether a measure is stable over time so that researchers can be confident that results relating to the measure for a sample of respondents will not fluctuate.
    - Internal reliability: It seeks to assess whether the indicators that make up the scale or index are consistent.
    - Inter-observer consistency: It may arise due to the involvement of more than one observer in activities such as recording of observation or translation of data into categories.
15. Validity assesses whether a measure of a concept really measures that concept, i.e., the extent to which the concept measures the thing it was designed to measure. When we have whole price index [WPI], does it really measure the increase in inflation? Here when questions are raised about the use of WPI as an accurate measure of inflation, the measurement validity of WPI in relation to inflation is being doubted.
16. The methods of measuring validity are: face validity, content validity, criterion validity and construct validity.

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2.10 QUESTIONS AND EXERCISES

Short-Answer Questions

1. Why is sampling required?
2. What are the steps required in sampling design process?
3. Write a short note on probability sampling.
4. What are non-sampling errors?
5. Discuss interview as a tool of data collection.

Long-Answer Questions

1. Write a note on the principal steps in a sample survey.
2. Discuss probability and non-probability samples.
3. Analyse observation as a tool for data collection.
4. What are the advantages and disadvantages of the case study method?
5. Elaborate on the four scales of data measurement.

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UNIT 3 PROCESSING AND PRESENTATION OF DATA

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Structure

3.0 INTRODUCTION

The second unit had discussed data collection through a variety of sampling techniques. Details of case method and survey method were also discussed in detail. Once the data has been collected, the next stage consists of data processing, which is the subject matter of this unit. This unit deals with the methods of processing and presenting data and analyses the processes of editing, coding, classification and tabulation. It also outlines a working knowledge of SPSS. Finally, it illustrates the utility of diagrams and graphs as tools for presentation of data.

3.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Explain the steps in data processing— coding, classification and tabulation
- Understand how to use SPSS package in order to process data
- Illustrate the utility of bar diagrams, pie diagrams, histograms as aids in presentation of data

3.2 DATA PROCESSING

Once the data has been collected, it needs to be carefully sorted and arranged before we can undertake a meaningful analysis. Quantitative as well as qualitative data needs to be sorted, coded or categorized, or indexed as the case may be and thus made ready for analysis.

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3.2.1 Editing, Coding, Classification and Tabulation

Coding refers to the process of conceptualizing research data and classifying them into meaningful and relevant categories for the purpose of data analysis and interpretation. A number is assigned to each category in the form of a code. For example, if the field relates to caste, code 1 can be given for general category candidates, code 2 for persons belonging to Scheduled Castes and code 3 for Scheduled Tribes and Code 4 for Other Backward Castes. Coding formats may be included in the questionnaire. In case-respondent's replies do not fall into pre-coded response categories, that is, in the case of open-ended questions and for pre-coded questions which have an 'other' code, coding formats can be developed after the data have been collected.

The following are some rules for development of the coding scheme known as the *coding frame* for quantitative data:

1. The codes must be mutually exclusive
2. Coding formats for each question must be comprehensive and
3. Codes must be consistently applied by field investigators or data entry operators

On the other hand, coding rules for qualitative data permit the allocation of responses to more than one category in order to facilitate conceptual development. Interview data can be coded by the interviewer during or after the interview, i.e., coding can be done directly on to the hard copy of the questionnaire while on field. However, it often requires coding in the office by a data entry operator or a team of data entry operators.

Kultar Singh (2007: 82) has given a detailed account of issues related to coding.

(a) **Coding boxes:** While designing questionnaires, coding boxes should be allocated for each question. It is important to note that each coding box must contain only one number. In case there are answers that require a two-digit code, two coding boxes must be provided—one for each number.

(b) **Coding transfer sheets:** In a majority of cases, pre-coded questionnaires are used for data entry though in some cases, coding transfer sheets for each questionnaire containing the transferred codes from each question, are also used. Coding transfer sheets are used in cases where the investigator does not wish to clutter the questionnaire with numerical codes and coding boxes, but it doubles the administrative effort and data entry costs.

Irrespective of the method used, they must specify exactly where the individual's computer records of each item of data is to be placed. This is usually done by allocating variable names to each question, which are stored in the computer's data entry programme in a pre-defined sequence as well as on the coding frame.

(c) **Numerical values for codes:** In the case of quantitative analysis, it is essential that the collected information is coded either quantitatively in the form of measurement such as weight in kilogrammes or qualitatively, in the form of a category so that the numbers in each group can be counted. Thus, for caste, it is General, SC, ST and OBC; for marital status, the groups are married, single, widowed, divorced and separated. Further, each of the categorized groups to be analysed require a numeric value before they can be entered on to the computer, counted and analysed. For example, in case where there are two responses to a field such as male and female, choices could be scored 1 and 2 respectively.

(d) **Coding open questions:** Open-ended questions form an integral part of the questionnaire as it allows respondents to use their own words and form their own response categories. The responses to open-ended questions are then listed by the investigator after the data has been collected. This can be grouped by theme for the development of an appropriate coding framework. Even in the case of structured questionnaire, pre-coded response options have the provisions for the 'others' category, thus making it imperative that a list is prepared to develop a coding frame from the various 'other' response choices that were offered to respondents and whose replies did not fit the codes given.

(e) **Coding closed questions:** Closed-ended questions require that any groupings should be defined before data is collected. The response is then collected to the pre-defined category, with a number assigned. The response is then an item of data ready for transfer to coding boxes, data-entry and analysis.

Classification and tabulation

Statistical tools are helpful in condensing large amounts of data. It also facilitates drawing of useful inferences from data. For instance, given below are the marks obtained by 50 students in their Social Anthropology paper.

Table: Marks obtained by 50 students in Social Anthropology paper

35	70	65	44	50	66	42	12	18	30
55	66	78	19	67	43	65	59	58	52
60	62	58	55	54	67	62	35	44	74
77	65	64	70	25	29	45	40	60	35
45	60	58	56	55	54	70	72	75	33

When information is presented in the above manner, it does not make much sense. One cannot make head or tail of out of the above table or mass of data. In practice, the data is likely to be much larger. Suppose we group the above data in certain class intervals as follows:

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Marks	No. of students
10–19	3
20–29	2
30–39	5
40–49	7
50–59	10
60–69	12
70–79	7

While preparing the above table, the data was classified. For instance, let us take the students who scored 50 to 59 marks. When we come across the first student, we can put a tally mark I. We can go on adding them until we reach four students and while counting fifth student, we can tabulate it in the following manner ~~IIII~~. This stands for five and enables easy classification and tabulation of quantitative data.

The above type of classification of information is called a *frequency table*. It shows marks which are grouped in a class interval and also number of students falling in each class interval. It is important to note that the classes should be exhaustive or in other words, every value should be included in one or the other classes. They should also be mutually exclusive and non-overlapping. The number of classes should neither be too large nor too small. It could be between 5 and 15 but there are no hard and fast rules.

3.3 USE OF SPSS IN REASEARCH

Several computer packages have been developed to assist researchers in the task of data analysis. They include MS Excel, Mintab and SPSS. These statistical software packages have indeed made the task of researchers easier by facilitating data analysis. MS Excel is a part of MS Office package developed by Microsoft Corporation. There are several user-friendly features in MS Excel. Even if one were not formally trained in MS Excel, one can use interactive 'help' feature to navigate. It uses spreadsheets and help in handling numerical data. There is a tool for data analysis available as a part of MS Excel. It can be used to perform various types of analysis on spreadsheet.

In 1968, Norman H. Nie, C. Hadlai Hull and Dale H. Brent developed SPSS which is now used widely in academic, business, government and other environments. 'SPSS' stands for 'Statistical Product and Service Solutions'. The company owning SPSS seeks to 'drive the widespread use of data in decision making'. SPSS is a statistical software package which has the following functions on its menu bar: Data, Transform, Analyze and Graph. These facilitate data analysis and a variety of numerical operations like tables, graphs, correlation, regression analysis, non-parametric tests, comparing means by one-way ANNOVA test and two-way ANNOVA test, etc.

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SPSS is a comprehensive, integrated software package for statistical data analysis. SPSS for Windows allows one to store data, perform transformations and analyses, and produce charts and graphs of results. Data are entered using a spreadsheet and results are displayed in a separate output window. The data and the output can be saved independently for the next work session. The output tables can be copied to a word processing application for inclusion in papers. There are useful tips on how to create a data set, entering data into a data set, working with a data set, data directory, analysis of data set, computing mean, standard deviation, performing a number of statistical tests like 't' test and chi-square test, etc.

3.3.1 Terminology Used in SPSS

The University of Lincoln has developed a nice guide which serves as a brief introduction to statistical language as required by SPSS. It requires data in a format where cases are represented by rows, and variables by columns. A collection of data to be analysed is called a *dataset*.

A *case* is the basic unit of analysis; for example, this might be an animal being used in a medical experiment; a single person filling in a questionnaire or a plant used in a genetic study. The items measured and recorded in each case are the variables. These could be a reply to a question of a survey, like the body mass of an insect or length of leaves of a plant, etc. Variables may either be *categorical* or *continuous*.

When within a variable, values are measured on a continuous scale between appropriate limits, for example, 1 to 10, the variable is termed as continuous. In practice, values are measured till a certain degree of accuracy, may be till two decimal places or till the nearest integer. Mean, standard deviation and other such descriptive statistics are calculated often on *continuous variable.*

A variable with values that may only come from a fixed set of choices is named a *categorical variable*. The categories are known as levels and the variables known as factors. There might be no relationship between the categories; gender and occupation belong to such type of category. Bar charts and frequency tables are examples of such type of such categories. Tables may be created for analysis by cross-tabulating categorical variables. An ordered categorical variable may have values divided into low, medium and high ordered sequences. The median for the variable may be calculated in case the values are numeric. Continuous variables may form ordered categorical variable by grouping the values, example, age ranges such as 13–16; 17–20, etc.

Physical measurement has a level of precision. We know that the space or interval between 2 and 3 inches is the same as that between 3 and 4 inches on a ruler. This measurement scale possesses the *interval property*. Most measurements also possess *ratio property*. This means that when the measurement scales states that you now have twice as many units of the variable as before, you really do; for example, when it takes someone 20 minutes to do an exercise, it has taken him

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twice as long to do that exercise as someone who took 10 minutes. Scales possessing interval property and ratio property are known as *ratio scales*. *Interval scales* do not have ratio property but only interval property. These occur very rarely, e.g., measurement of temperature.

Physical measurement has a level of precision. The inch marks on a ruler are equally spaced; we know that the space or interval between 2 and 3 inches is the same as that between 3 and 4 inches. It can be stated that this measurement scale possesses the *interval property*.

Most measurements also possess *ratio property*. This means that when the measurement scales states that you now have twice as many units of the variable as before, you really do; for example when it takes someone 20 minutes to do an exercise, it has taken that subject twice as long to do that exercise as someone who took 10 minutes. Scales which have the ratio property in addition to the interval property are known as *ratio scales*.

Some scales have the interval property and do not have the ratio property. These are called *interval scales*. These occur very rarely, e.g., measuring temperature.

Statistics program

Statistics included in the base software:

- Descriptive statistics: Cross tabulation, frequencies, descriptives, explore, descriptive ratio statistics
- Bivariate statistics: Means, t-test, ANOVA, Correlation (bivariate, partial, distances), Nonparametric tests
- Prediction for numerical outcomes: Linear regression
- Prediction for identifying groups: Factor analysis, cluster analysis (two-step, K-means, hierarchical)

The many features of SPSS are accessible via pull-down menus or can be programmed with a proprietary 4GL *command syntax language*. Command syntax programming has the benefits of reproducibility, simplifying repetitive tasks, and handling complex data manipulations and analyses. Additionally, some complex applications can only be programmed in syntax and are not accessible through the menu structure. The pull-down menu interface also generates command syntax. This can be displayed in the output though the default settings have to be changed to make the syntax visible to the user; or can be pasted into a syntax file using the 'paste' button present in each menu. Programs can be run interactively, or unattended using the supplied Production Job Facility. Additionally, a 'macro' language can be used to write command language subroutines and a Python programmability extension can access the information in the data dictionary and data and dynamically build command syntax programs. The Python programmability extension, introduced in SPSS 14, replaced the less functional SAX Basic 'scripts' for most purposes, although SaxBasic remains available. In addition, the Python