BUSINESS RESEARCH METHODS
(UNIT – 3)
For B.Com (Hons.) 6th Semester

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MEASUREMENT

Definition of Measurement

Measurement, the process of associating numbers with physical quantities and phenomena. Measurement is fundamental to the sciences; to engineering, construction, and other technical fields; and to almost all everyday activities. For that reason the elements, conditions, limitations, and theoretical foundations of measurement have been much studied.

Designing and Writing Items of Measurement

- **Measure** is important in research. ...
- Basically, the events or phenomena that researchers interested can be existed as domain. ...
- Quantitative **Measurement** is a quantitative description of the events or characteristics which involves numerical **measurement**.

Uni-dimensional and Multi-dimensional Scales

- **Unidimensional** constructs are those that are expected to have a single underlying dimension. These constructs can be measured using a single measure or test. Examples include simple constructs such as a person's weight, wind speed, and probably even complex constructs like self-esteem (if we conceptualize self-esteem as consisting of a single dimension, which of course, may be a unrealistic assumption).

- **Multidimensional** constructs consist of two or more underlying dimensions. For instance, if we conceptualize a person's academic aptitude as consisting of two dimensions – mathematical and verbal ability – then academic aptitude is a multidimensional construct. Each of the underlying dimensions in this case must be measured separately, say, using different tests for mathematical and verbal ability, and the two scores can be combined, possibly in a weighted manner, to create an overall value for the academic aptitude construct.

Measurement of Scales – Nominal, Ordinal, Interval, Ratio

Nominal, Ordinal, Interval, and Ratio are defined as the four fundamental levels of measurement scales that are used to capture data in the form of surveys and questionnaires, each being a multiple choice question.

- **Nominal scale** is a naming scale, where variables are simply "named" or labeled, with no specific order. Ordinal scale has all its variables in a specific order, beyond just naming them. Interval scale offers labels, order, as well as, a specific interval between each of its variable options. Ratio scale bears all the characteristics of an interval scale, in addition to that, it can also accommodate the value of "zero" on any of its variables.
- **Ordinal Scale** is defined as a variable measurement scale used to simply depict the order of variables and not the difference between each of the variables. These scales are generally used to depict non-mathematical ideas such as frequency, satisfaction, happiness, a degree of pain, etc. It is quite straightforward to remember the implementation of this scale as 'Ordinal' sounds similar to 'Order', which is exactly the purpose of this scale.
- **Interval Scale** is defined as a numerical scale where the order of the variables is known as well as the difference between these variables. Variables that have familiar, constant, and computable differences are classified using the Interval scale. It is easy to remember the primary role of this scale too, 'Interval' indicates 'distance between two entities', which is what Interval scale helps in achieving.
- **Ratio Scale** is defined as a variable measurement scale that not only produces the order of variables but also makes the difference between variables known along with information on the value of true zero. It is calculated by assuming that the variables have an option for zero, the difference between the two variables is the same and there is a specific order between the options.

Ratings and Ranking Scale

- Rating scale questions are a variation of multiple choice. They ask the respondent (or members, as we refer to our consumer panel at Suzy™) to assign a value to a particular object or subject. Rating scales are close-ended questions that can help you gain quantitative data – information you can measure, hard facts. Rating scales allow you to collect data in a way that is easier to analyze and use.
- Ranking scales offer a different approach to gathering data—these questions ask respondents to compare items to *one another*, rather than rating them on a common scale. When trying to negotiate which items to remove from your dessert menu, for example, you might ask customers to rank the seven desserts you offer from their most favorite to least favorite, giving you insight into customer preferences.
- *Ranking vs Rating: Which is better?*
- Ranking and rating scales each have their advantages. They also both have a significant role in a survey. Neither question style can produce the best results on its own.
- The most accurate surveys combine both styles of questions, along with open-ended questions. But getting the most out of your survey isn't just about knowing which type of question to use. It also requires knowing *when* each style of question is appropriate.

Thurstone, Likert and Semantic Differential Scaling

- Thurstone scale was one of the first scales ever used to measure attitudes on different topics and issues. This scale contains a set of statements about a certain topic along with a numerical value depicting how favorable or unfavorable it is deemed to be.
- Likert scale is one of the most commonly used ways of measuring perceptions, attitudes, and opinions. It enables survey respondents to express their attitude by choosing one of the given answer options.

  Similarly to semantic differential questions, which offer two answer options with several grading levels in between, Likert scale questions are characterized by a wide range of options to choose from, usually ranging from one extreme (e.g. ‘strongly agree’) to another (e.g. ‘strongly disagree’).
- Semantic differential scale is a rating scale that begins and ends with rating options that are semantically opposite (usually polar adjectives, such as “like-dislike”, “satisfied-dissatisfied”, “would recommend-wouldn’t recommend”) and can contain various degrees of those options in between.

  Today, semantic differential scales are primarily used in questionnaires and surveys to obtain people’s emotional reaction or attitude towards a particular topic and to allow customers to rate products, services, brands, or organizations.

Paired Comparison

Paired Comparison Analysis (also known as Pairwise Comparison) helps you work out the importance of a number of options relative to one another.

This makes it easy to choose the most important problem to solve, or to pick the solution that will be most effective. It also helps you set priorities where there are conflicting demands on your resources.

The tool is particularly useful when you don't have objective data to use to make your decision. It's also an ideal tool to use to compare different, subjective options, for example, where you need to decide the relative importance of qualifications, skills, experience, and teamworking ability when hiring people for a new role.

Sampling – Steps, Types, Sample Size Decision

Steps in Sampling:

- **1. Defining the Target Population:**

  Defining the population of interest, for business research, is the first step in sampling process. In general, target population is defined in terms of element, sampling unit, extent, and time frame. The definition should be in line with the objectives of the research study.

- **2. Specifying the Sampling Frame:**

  Once the definition of the population is clear a researcher should decide on the sampling frame. A sampling frame is the list of elements from which the sample may be drawn.

- **3. Specifying the Sampling Unit:**

  A sampling unit is a basic unit that contains a single element or a group of elements of the population to be sampled.

Sampling – Steps, Types, Sample Size Decision (Contd.)

Steps in sampling (Continued)

- **4. Selection of the Sampling Method:**

  The sampling method outlines the way in which the sample units are to be selected. The choice of the sampling method is influenced by the objectives of the business research, availability of financial resources, time constraints, and the nature of the problem to be investigated. All sampling methods can be grouped under two distinct heads, that is, probability and non-probability sampling.

- **5. Determination of Sample Size:**

  The sample size plays a crucial role in the sampling process. There are various ways of classifying the techniques used in determining the sample size.

- **6. Specifying the Sampling Plan:**

  In this step, the specifications and decisions regarding the implementation of the research process are outlined.

- **7. Selecting the Sample:**

  This is the final step in the sampling process, where the actual selection of the sample elements is carried out. At this stage, it is necessary that the interviewers stick to the rules outlined for the smooth implementation of the business research. This step involves implementing the sampling plan to select the sampling plan to select a sample required for the survey.

Sampling – Steps, Types, Sample Size Decision (Contd.)

Types of Sampling:

- **A. Probability Sampling Methods**
- **1. Simple random sampling**

  In this case each individual is chosen entirely by chance and each member of the population has an equal chance, or probability, of being selected.
- **2. Systematic sampling**

  Individuals are selected at regular intervals from the sampling frame. The intervals are chosen to ensure an adequate sample size.
- **3. Stratified sampling**

  In this method, the population is first divided into subgroups (or strata) who all share a similar characteristic. It is used when we might reasonably expect the measurement of interest to vary between the different subgroups, and we want to ensure representation from all the subgroups.
- **4. Clustered sampling**

  In a clustered sample, subgroups of the population are used as the sampling unit, rather than individuals. The population is divided into subgroups, known as clusters, which are randomly selected to be included in the study.

Sampling – Steps, Types, Sample Size Decision (Contd.)

Types of Sampling (Continued)

- **Non-Probability Sampling Methods**
- **1. Convenience sampling**

  Convenience sampling is perhaps the easiest method of sampling, because participants are selected based on availability and willingness to take part. Useful results can be obtained, but the results are prone to significant bias, because those who volunteer to take part may be different from those who choose not to (volunteer bias), and the sample may not be representative of other characteristics, such as age or sex.
- **2. Quota sampling**

  This method of sampling is often used by market researchers. Interviewers are given a quota of subjects of a specified type to attempt to recruit.
- **3. Judgement (or Purposive) Sampling**

  Also known as selective, or subjective, sampling, this technique relies on the judgement of the researcher when choosing who to ask to participate. Researchers may implicitly thus choose a "representative" sample to suit their needs, or specifically approach individuals with certain characteristics. This approach is often used by the media when canvassing the public for opinions and in qualitative research.
- **4. Snowball sampling**

  This method is commonly used in social sciences when investigating hard-to-reach groups. Existing subjects are asked to nominate further subjects known to them, so the sample increases in size like a rolling snowball.

Sample Size Decision

Sample size determination is the act of choosing the number of observations or replicates to include in a statistical sample. The sample size is an important feature of any empirical study in which the goal is to make inferences about a population from a sample. In practice, the sample size used in a study is usually determined based on the cost, time, or convenience of collecting the data, and the need for it to offer sufficient statistical power. In complicated studies there may be several different sample sizes: for example, in a stratified survey there would be different sizes for each stratum. In a census, data is sought for an entire population, hence the intended sample size is equal to the population. In experimental design, where a study may be divided into different treatment groups, there may be different sample sizes for each group.

- Sample sizes may be chosen in several ways:
- using experience – small samples, though sometimes unavoidable, can result in wide confidence intervals and risk of errors in statistical hypothesis testing.
- using a target variance for an estimate to be derived from the sample eventually obtained, i.e. if a high precision is required (narrow confidence interval) this translates to a low target variance of the estimator.
- using a target for the power of a statistical test to be applied once the sample is collected.
- using a confidence level, i.e. the larger the required confidence level, the larger the sample size (given a constant precision requirement).

Secondary Data Sources

- **Secondary data** refers to data that is collected by someone other than the primary user. Common sources of secondary data for social science include censuses, information collected by government departments, organizational records and data that was originally collected for other research purposes. Primary data, by contrast, are collected by the investigator conducting the research.
- Secondary data analysis can save time that would otherwise be spent collecting data and, particularly in the case of quantitative data, can provide larger and higher-quality databases that would be unfeasible for any individual researcher to collect on their own. In addition, analysts of social and economic change consider secondary data essential, since it is impossible to conduct a new survey that can adequately capture past change and/or developments. However, secondary data analysis can be less useful in marketing research, as data may be outdated or inaccurate.
- Secondary data can be obtained from different sources:
- information collected through censuses or government departments like housing, social security, electoral statistics, tax records
- internet searches or libraries
- GPS, remote sensing
- km progress reports

HYPOTHESIS TESTING

Test Concerning Means and Proportions

Hypothesis Testing for the Mean

Here, we would like to discuss some common hypothesis testing problems. We assume that we have a random sample X1,X2,...,Xn from a distribution and our goal is to make inference about the mean of the distribution μ. We consider three hypothesis testing problems. The first one is a test to decide between the following hypotheses:

H0: μ=μ0
H1: μ≠μ0

In this case, the null hypothesis is a simple hypothesis and the alternative hypothesis is a *two-sided* hypothesis (i.e., it includes both μ<μ0 and μ>μ0). We call this hypothesis test a *two-sided* test. The second and the third cases are *one-sided* tests. More specifically, the second case is

H0: μ≤μ0,
H1: μ>μ0.

Here, both H0 and H1 are one-sided, so we call this test a *one-sided* test. The third case is very similar to the second case. More specifically, the third scenario is

H0: μ≥μ0,
H1: μ<μ0 .

In all of the three cases, we use the sample mean

Mean = (X1+X2+...+Xnn) / n

to define our statistic

Test Concerning Means and Proportions (Contd..)

Hypothesis Testing for the Proportion

- State the Hypotheses
- Every hypothesis test requires the analyst to state a null hypothesis and an alternative hypothesis. The hypotheses are stated in such a way that they are mutually exclusive. That is, if one is true, the other must be false; and vice versa.
- Formulate an Analysis Plan
- The analysis plan describes how to use sample data to accept or reject the null hypothesis. It should specify the following elements.
- Significance level. Often, researchers choose significance levels equal to 0.01, 0.05, or 0.10; but any value between 0 and 1 can be used.
- Test method. Use the one-sample z-test to determine whether the hypothesized population proportion differs significantly from the observed sample proportion.
- Analyze Sample Data
- Using sample data, find the test statistic and its associated P-Value.
- Standard deviation. Compute the standard deviation (σ) of the sampling distribution.
- $\sigma = \text{sqrt}[P * (1 - P) / n]$
- where P is the hypothesized value of population proportion in the null hypothesis, and n is the sample size.
- Test statistic. The test statistic is a z-score (z) defined by the following equation.
- $z = (p - P) / \sigma$
- where P is the hypothesized value of population proportion in the null hypothesis, p is the sample proportion, and σ is the standard deviation of the sampling distribution.
- P-value. The P-value is the probability of observing a sample statistic as extreme as the test statistic. Since the test statistic is a z-score, use the Normal Distribution Calculator to assess the probability associated with the z-score. (See sample problems at the end of this lesson for examples of how this is done.)
- Interpret Results
- If the sample findings are unlikely, given the null hypothesis, the researcher rejects the null hypothesis. Typically, this involves comparing the P-value to the significance level, and rejecting the null hypothesis when the P-value is less than the significance level.

ANOVA

- What is Analysis of Variance (ANOVA)?

  Analysis of variance (ANOVA) is an analysis tool used in statistics that splits an observed aggregate variability found inside a data set into two parts: systematic factors and random factors. The systematic factors have a statistical influence on the given data set, while the random factors do not. Analysts use the ANOVA test to determine the influence that independent variables have on the dependent variable in a regression study.

- What Does the Analysis of Variance Reveal?

  The ANOVA test is the initial step in analyzing factors that affect a given data set. Once the test is finished, an analyst performs additional testing on the methodical factors that measurably contribute to the data set's inconsistency. The analyst utilizes the ANOVA test results in an f-test to generate additional data that aligns with the proposed regression models.

  The ANOVA test allows a comparison of more than two groups at the same time to determine whether a relationship exists between them. The result of the ANOVA formula, the F statistic (also called the F-ratio), allows for the analysis of multiple groups of data to determine the variability between samples and within samples.

ANOVA (Contd.)

- One-Way ANOVA Versus Two-Way ANOVA

  There are two main types of ANOVA: one-way (or unidirectional) and two-way. There also variations of ANOVA. For example, MANOVA (multivariate ANOVA) differs from ANOVA as the former tests for multiple dependent variables simultaneously while the latter assesses only one dependent variable at a time. One-way or two-way refers to the number of independent variables in your analysis of variance test. A one-way ANOVA evaluates the impact of a sole factor on a sole response variable. It determines whether all the samples are the same. The one-way ANOVA is used to determine whether there are any statistically significant differences between the means of three or more independent (unrelated) groups.

  A two-way ANOVA is an extension of the one-way ANOVA. With a one-way, you have one independent variable affecting a dependent variable. With a two-way ANOVA, there are two independents. For example, a two-way ANOVA allows a company to compare worker productivity based on two independent variables, such as salary and skill set. It is utilized to observe the interaction between the two factors and tests the effect of two factors at the same time.

Chi-square Test

A **chi-squared test**, also written as **χ^2 test**, is a statistical hypothesis test that is valid to perform when the test statistic is chi-squared distributed under the null hypothesis, specifically Pearson's chi-squared test and variants thereof. Pearson's chi-squared test is used to determine whether there is a statistically significant difference between the expected frequencies and the observed frequencies in one or more categories of a contingency table.

In the standard applications of this test, the observations are classified into mutually exclusive classes. If the null hypothesis that there are no differences between the classes in the population is true, the test statistic computed from the observations follows a χ^2 frequency distribution. The purpose of the test is to evaluate how likely the observed frequencies would be assuming the null hypothesis is true.

Test statistics that follow a χ^2 distribution occur when the observations are independent and normally distributed, which are assumptions often justified under the central limit theorem. There are also χ^2 tests for testing the null hypothesis of independence of a pair of random variables based on observations of the pairs.

Chi-squared tests often refer to tests for which the distribution of the test statistic approaches the χ^2 distribution asymptotically, meaning that the sampling distribution (if the null hypothesis is true) of the test statistic approximates a chi-squared distribution more and more closely as sample sizes increase.

The formula for the chi-square statistic used in the chi square test is:

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

The subscript "c" is the degrees of freedom. "O" is your observed value and E is your expected value. It's very rare that you'll want to actually *use* this formula to find a critical chi-square value by hand. The summation symbol means that you'll have to perform a calculation for every single data item in your data set.

Testing the Assumptions of Classical Normal Linear Regression

- 1. The regression model is linear, correctly specified, and has an additive error term.
- 2. The error term has a zero population mean.
- 3. All explanatory variables are uncorrelated with the error term.
- 4. Observations of the error term are uncorrelated with each other (no serial correlation).
- 5. The error term has a constant variance (no heteroskedasticity).
- 6. No explanatory variable is a perfect linear function of any other explanatory variables (no perfect multicollinearity).
- 7. The error term is normally distributed (not required).

Thank You