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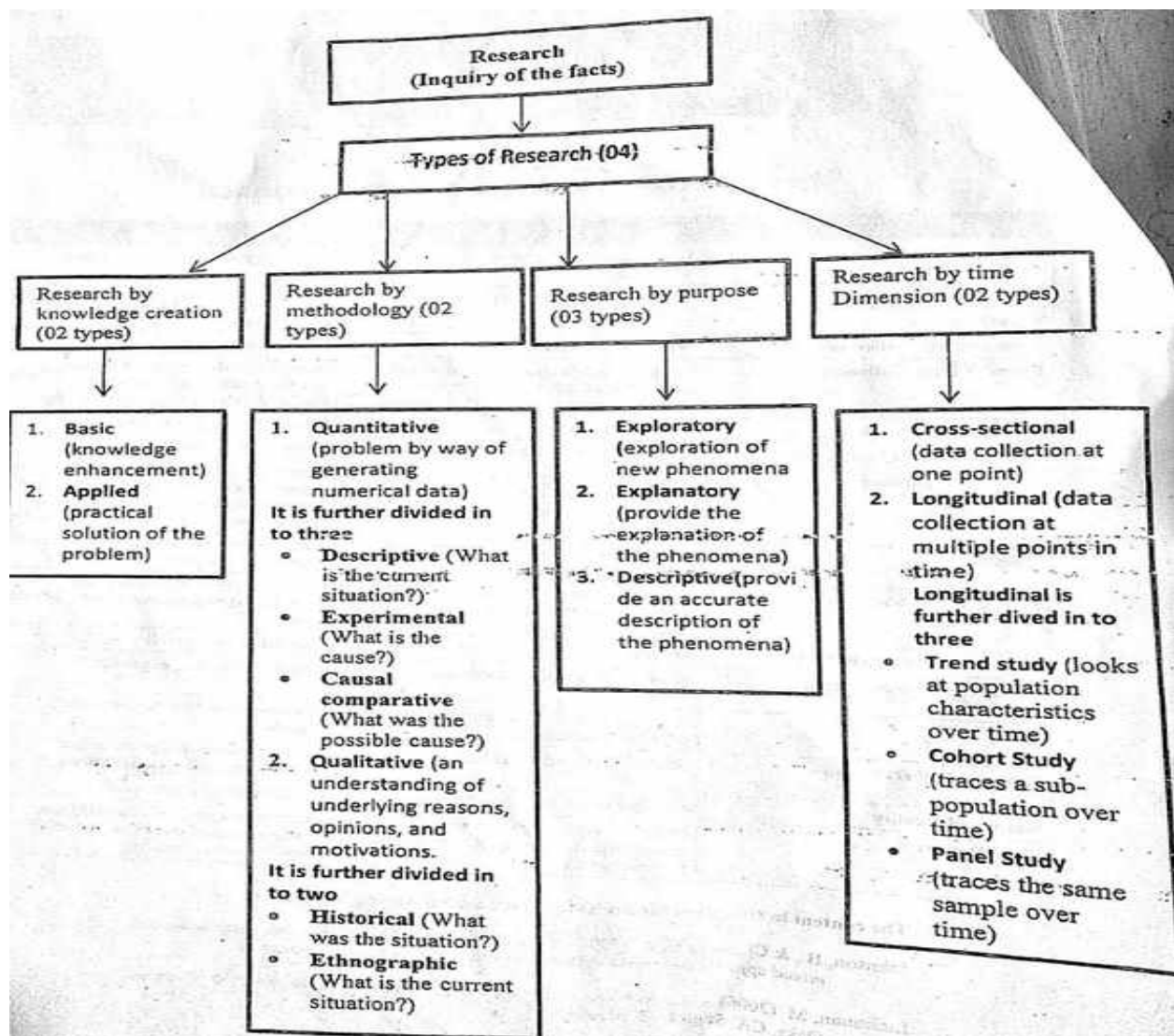
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Lesson 01INTRODUCTION OF QUANTITATIVE RESEARCHTopic 001: Introduction**Research**

Research is defined as the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies and understandings. This could include synthesis and analysis of previous research to the extent that it leads to new and creative outcomes.

Types of Research**What is quantitative research?**

Quantitative research collects and uses numerical data to explore, describe, explain, or predict trends or phenomena. Quantitative research emphasizes objectivity and the control of contextual factors that may impact the results. Quantitative research states hypotheses and relies on statistical analysis to support conclusions made regarding the hypothesis.

Definitions of Quantitative Research by Scholars

Aliaga and Gunderson (2002) have described the quantitative research as “Quantitative research is an inquiry into a social problem, explain phenomena by gathering numerical data that are analyzed using mathematically based methods e.g. in particular statistics”.

According to the Creswell (2003) researcher primarily uses post-positivist approach to develop knowledge when quantitative research is selected (i.e cause and effect thinking, use of measurement and observations, and test of theories), employs strategies of inquiry such as experiments and surveys, and collects data on predetermined instruments that yield statistical data.

Purpose of Quantitative Research

The main reasons behind the quantitative research are enlisted below;

Exploratory: Quantitative research investigates issues with the goal of providing insight and information to the researcher. The quantitative research use pilot studies to test feasibility or value of working in an area; focus groups to guide survey design.

Description: The quantitative research describe the current situation or classify situations, events or groups and often use large scale data sets e.g. Surveys; correlational studies

Explanation: The quantitative research build, enrich, and explain theories. It also test theories using quantitative methods

Prediction: The quantitative research establish predictors of some behavior. There are two types of variables – predictor and criterion (outcome). Regression analysis is one statistical procedure used for prediction

Evaluation: The quantitative research evaluates programs for their efficacy, come in different forms and serve different functions

Aim of the Research

- The primary aim of a Quantitative Research is to focus more in counting and classifying features and constructing statistical models and figures to explain what is observed.
- Quantitative Research is highly recommended because it provides the researcher a clearer picture of what to expect in his research compared to Qualitative Research.

Features of Quantitative Research

Its main features are enlisted below:

- The Quantitative research use structured research instruments for data collection.
- The results are based on larger sample sizes that are representative of the population.
- The research study can usually be replicated or repeated, given its high reliability.
- The researcher has a clearly defined research question to which objective answers are sought.
- All aspects of the study are carefully designed before data is collected.
- Data are in the form of numbers and statistics, often arranged in tables, charts, figures, or other non-textual forms.
- The Quantitative research can be used to generalize concepts more widely, predict future results, or investigate causal relationships.

- The researcher uses tools, such as questionnaires and interview schedule to collect numerical data.

Parts of Quantitative Research

There are four parts of Quantitative Research such as;

1. **Measurement:** Check reliability, validity, random and systematic errors in research).
2. **Sampling:** Key is that sample is representative of population to make a generalization in interpretation).
3. **Research Design:** How to set up data collection to minimize counter interpretations to the results).
4. **Statistical Procedures:** Descriptive and Inferential statistic

Advantages of Quantitative Research Approach

The advantage of the quantitative research is mentioned in the following;

- The use of statistical data as a tool for saving time and resources.
- Quantitative research approach can be seen as being scientific in nature.
- The use of scientific methods for data collection and analysis make generalization possible.
- Replicability is another benefit of the quantitative research.
- The quantitative research relies on hypotheses testing, the researcher need not to do intelligent guesswork, rather he would follow clear guidelines and objectives.
- This quantitative research gives room for the use of control and study groups in experiment setting.
- The quantitative research as “researcher detachment” research approach which reduce the chances of biasness.
- The quantitative research may guarantee respondent anonymity.

Disadvantages of Quantitative Research Approach

- Researcher detachment from the participants is also a weakness within the quantitative research. Researcher detachment means that he is an “observer” or an “outside looking in”.
- In the quantitative research, the participants have no room to contribute to the study. The researcher is at the “driver’s seat”.
- The linear and non-flexible nature of a quantitative approach demands that the researcher follow a certain order. He starts by setting the research question and hypotheses, conducts a literature review, collects data, analyses the data and summarizes the result.
- A quantitative research is characterized as being structured with predetermined variables, hypotheses and design. As a result of using predetermined working strategies, the approach does not require or encourage imaginative, critical and creative thinking.

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Lesson 02**RESEARCH PROCESS IN QUANTITATIVE RESEARCH****Topic 002: Research Process****Introduction**

A Research process consists of series of actions or steps necessary to effectively carry out research and the desired sequencing of these steps. Research process consist of a number of closely related activities. Various steps involved in a research process are not mutually exclusive; nor they are separate & distinct. The research process provides to produce new knowledge, or to offer a new manner of understanding present knowledge.

Steps in Quantitative Research Process**Step – 1: Identifying the Problem/Topic**

The first and foremost task in the entire process of quantitative research is to identify a research problem or topic. A well-identified problem will lead the researcher to accomplish all-important phases of the research process, starting from setting objectives to the selection of the research methodology. This may be a general area of study or an issue of professional or personal interest. Topics are broad, such as the effects of divorce, reasons for delinquency, impact of homelessness, or how elites use the media

Step – 2: Reviewing of Literature

A review of relevant literature is an integral part of the research process. It enables the researcher to formulate his problem in terms of the specific aspects of the general area of his interest that has not been so far researched. Such a review, not only provides him exposure to a larger body of knowledge but also equips him with enhanced knowledge to efficiently follow the research process. To ignore the existing literature may lead to wasted effort on the part of the researchers. If the researcher is aware of earlier studies of his topic, or related topics, he will be in a much better position to assess the significance of his work and to convince others that it is important. In sum, we enumerate the following arguments in favor of reviewing the literature:

- It avoids duplication of the work that has been done in the recent past.
- It helps the researcher to find out what others have learned and reported on the problem.
- It helps the researcher to become familiar with the types of methodology followed by others.
- It helps the researcher to understand what concepts and theories are relevant to his area of investigation.
- It helps the researcher to understand if there are any significant controversies, contradictions, and inconsistencies in findings.
- It allows the researcher to understand if there are any unanswered research questions.
- It might help the researcher to develop an analytical framework.
- It will help the researcher to consider the inclusion of variables in his research that he might not otherwise have thought about.

Step – 3: Setting research questions, objectives, and hypotheses

A topic is too broad for actually conducting a study. We must narrow the topic to focus on a specific **research question** that a study can address. Often this requires reviewing the research literature and developing hypotheses that often come from social theory. For example, a broad topic—reasons for delinquency—becomes the focused research question: Are teenage East Asian immigrant males with strong ties to their home culture and who have not assimilated into the new society more likely to engage in delinquent acts than those with weaker home culture ties and who have assimilated? Notice how the initial broad topic, reasons for delinquency, becomes focused. We focus on a specific reason for delinquency (i.e., degree of assimilation) and look at a specific group of people (i.e., teenaged immigrant males from East Asia). An **objective** will precisely say what should be researched, to delineate the type of information that should be collected, and provide a framework for the scope of the study. The best expression of a research objective is a well-formulated, testable research hypothesis. A **hypothesis** is an unproven statement or proposition that can be refuted or supported by empirical data. Hypothetical statements assert a possible answer to a research question.

Step -4: Choosing the study design

Once we settle on a research question, we need to design the study. The research design is the blueprint or framework for fulfilling objectives and answering research questions. It is a master plan specifying the methods and procedures for collecting, processing, and analyzing the collected data. There are four basic research designs that a researcher can use to conduct his or her study;

1. Survey,
2. Experiment,
3. Secondary data study
4. Observational study.

The type of research design to be chosen from among the above four designs depends primarily on four factors:

- The type of problem
- The objectives of the study,
- The existing state of knowledge about the problem that is being studied, and
- The resources are available for the study.

Step – 5: Deciding on the sample design

Sampling is an important and separate step in the research process. The basic idea of sampling is that it involves any procedure that uses a relatively small number of items or portions of a universe to conclude the whole population.

A **population** is the total collection of elements about which we wish to make some inference or generalization.

A **sample** is a part of the population, carefully selected to represent that population. If certain statistical procedures are followed in selecting the sample, it should have the same characteristics as the population as a whole.

Sample design refers to the methods to be followed in selecting a sample from the population and the estimating technique, vis-a-vis formula for computing the sample statistics. The basic question is, then, how to select a sample? To answer this question, we must have acquaintance with the sampling methods. These methods are basically of two types: probability sampling and non-probability sampling. Probability sampling ensures every unit have equal chance of selection within the target population. The most widely used probability sampling methods are **simple random sampling, stratified random sampling, cluster sampling, and systematic sampling**. They have been classified by their representation basis and unit selection techniques.

If there is no feasible alternative, a non-probability sampling method may be employed. The basis of such selection is entirely dependent on the researcher's discretion. This approach is variously called judgment sampling, convenience sampling, accidental sampling, and purposive sampling.

Step – 6: Collecting data

After we design a study in detail, we must carefully record and verify information typically in the form of numbers. Next we must transfer numerical data into a computer-readable format if it is not already in that format.

Step-7: Processing and Analyzing Data

Data processing generally begins with the editing and coding of data. Data are edited to ensure consistency across respondents and to locate omissions. The coding process facilitates processing the data. The personal computer offers an excellent opportunity in data editing and coding processes. The techniques to be used in analyzing data may range from simple graphical technique to very complex multivariate analysis depending on the objectives of the study, research design employed, and the nature of data collected. This step usually requires the use of computer software to manipulate the numerical data to create many charts, tables, graphs, and statistical measures. These computer-generated documents provide a condensed picture of the data. After we produce charts, tables, and statistics, we must determine what they mean. We examine the analyzed data, use knowledge of the research topic, and draw on theory to answer our research question. We consider alternative interpretations of the data, compare our results with those of past studies, and draw out wider implications of what we have learned.

Step-8: Writing the report

At this stage, we write a report about the study in a specific format and present a description of both the study and its results. It is necessary to prepare a report and transmit the findings and recommendations to administrators, policymakers, and program managers for the intended purpose of making a decision. The dissemination may be made through a conference, a seminar, a report, or an oral or poster presentation.

Examples of Quantitative Research

Example 1

Authors and title of the study

Lowery and colleagues (2007) “Long-Term Effects of Subliminal Priming on Academic Performance”

1. Select a topic: Priming and academic performance

2. Focus the question: Do undergraduate college students who are “primed” subliminally with intelligence-related words improve their performance on a test? Subliminally means to present something in a way so that the receiver is not consciously aware of it. Priming occurs when a word, image, or information alerts, prepares or “sets up” a person for a subsequent behavior.

3. Design the study: The authors conducted two similar experiments. The first was with seventy students in a beginning undergraduate statistics class. The second was with seventy-eight students in an introduction to social psychology class. In both experiments, the authors showed students words on different sides of a computer screen. They told students that the study was about their ability to locate the words (this was not true). One random half of students saw words related to intelligence (e.g., sharp, bright, genius, educated). The other random half saw unrelated words. Students in both experiments took a practice exam. A few days later, they took the exam in their course.

4. Collect the data: Data for this study were test results for both the practice and actual exam in both the statistics and introduction to social psychology classes.

5. Analyze the data: The authors looked at various tables and conducted statistical tests.

6. Interpret the data: The results showed that the students in both classes who had been exposed or “primed” with intelligence-related words scored much higher on both tests.

7. Inform others: A description of the study with its results appeared in the scholarly journal Basic and Applied Social Psychology.

How does theory fit in? The authors retested a theory of subliminal priming. They looked at whether effects can continue for several days after a priming event.

Example 2

Authors and title of the study: Penny Edgell and Eric Tranby (2007) “Religious Influences on Understandings of Racial Inequality in the United States”

1. Select a topic: Religion and racial attitudes

2. Focus the question: Does a white evangelical Christian subculture and belief system encourage or discourage an individualist, nonsupportive stance toward inequality and toward African Americans?

3. Design the study: The authors prepared a large scale national survey in 2003 involving 2,081 randomly selected adults in the United States.

4. Collect the data: The randomly selected adults answered many questions on social backgrounds, religious practice and belief, explanations of racial inequality, and beliefs about African Americans in a 30-minute telephone interview.

5. Analyze the data: The authors looked at numerous tables with percentages and statistical tests.

6. Interpret the data: The authors found that survey respondents with strong conservative Protestant Christian beliefs and who were most involved in religious activities favored individualistic explanations of Black inequality (i.e., personal failings, lack of motivation) over structural explanations (i.e., racial discrimination). In addition, among conservative Christians, the views of women differed from men, and the educated from the less educated.

7. Inform others: The authors prepared a description of the study with its results that they submitted to the scholarly journal *Social Problems*.

How does theory fit in?

The authors examined a theory suggesting that a white evangelical subculture fosters particular attitudes about social and political issues; it deemphasizes structural explanations (discrimination, government help) and emphasizes individualist, self-help explanations.

Example 3

Authors and title of the study:

Rory McVeigh and Julian Sobolewski (2007) “Red Counties, Blue Counties, and Occupational Segregation by Sex and Race”

1. Select a topic: Social inequality and voting

2. Focus the question: Did occupational segregation by gender and race—a major source of social inequality—influence how people voted in the 2004 U.S. presidential election? Occupational segregation occurs when one group (e.g., one gender, one race) almost exclusively holds a type of job.

3. Design the study: The authors identified specific factors for which the government collects data at the county level: choice of presidential candidate and occupational segregation by race and gender. They also considered features of the labor market in a county (e.g., racial mix of the county, educational credentials of women and non-Whites, degree of mobility into a county) that might threaten or weaken the degree of occupational segregation.

4. Collect the data: Data came from the U.S. census on occupations, demographics, and voting.

5. Analyze the data: The authors examined numerous correlations, charts, and statistical tests.

6. Interpret the data: The authors found that both occupational and sex segregation in county level labor markets to be related to election outcomes. In counties that had equal or integrated labor markets, the Democratic Party candidate received more votes. In counties with highly segregated labor markets, especially with other conditions that threatened to undermine the segregation, the Republican Party candidate received more votes.

7. Inform others: The authors submitted a description of the study with its results to the scholarly journal *American Journal of Sociology*.

How does theory fit in? The authors used ethnic competition theory and split labor market theory to explain how county-level inequality influence the local political climate and voting behavior.

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Lesson 03**PHILOSOPHICAL STANDPOINT OF THE QUANTITATIVE RESEARCH****Topic 003: Philosophical Standpoint of the Quantitative Research****Research Paradigm**

A research paradigm is “the set of common beliefs and agreements shared between scientists about how problems should be understood and addressed” (Kuhn, 1962). In simple words, a paradigm is ‘a basic set of beliefs that guide action.

There are many definitions of paradigm. In general, a scientific paradigm is a whole system of thinking. It includes basic assumptions, the important questions to be answered or puzzles to be solved, the research techniques to be used, and examples of what good scientific research is like.

Components of Research paradigm

According to Guba (1990), research paradigms can be characterized through their:

Ontology – What is reality?

Researchers view of the nature of reality. What assumptions do we make about the way in which the world works?

Epistemology – How do you know something?

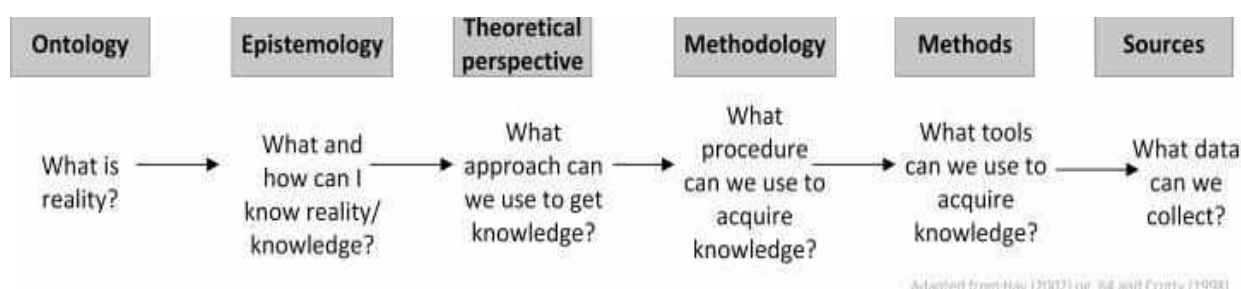
What nature of knowledge. Researchers view on what constitutes acceptable knowledge. What is the relationship between the knower (the researcher) and the knowable?

Axiology– How much values involved in the study?

Researchers view on role of value/ethics in research methodology. How should the researcher/inquirer go about finding out knowledge?

Methodology – How do you go about finding it out?

Methodology is “the strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of the methods to the desired outcomes.” Crotty, (2003: 3).



Couch (1987:106) summarized the different approaches as follows: The ontological and epistemological positions of these . . . research traditions provide the foundation of one of the more bitter quarrels in contemporary sociology. . . . Each side claims that the frame of thought they promote provides a means for acquiring knowledge about social phenomena, and each regards the efforts of the other as at best misguided. . . . They [the positions] differ on what phenomena should be attended to, how one is to approach phenomena, and how the phenomena are to be analyzed. The quote mentions two areas of philosophy, ontology and epistemology.

All scientific research rests on assumptions and principles from these two areas whether or not a researcher acknowledges them. We do not need a deep discussion over philosophical assumptions to conduct research; however, we make choices implicitly among them when we do a study. Most of us accept assumptions without question. However, by becoming aware of the assumptions, you can better understand what underlies your choices about research. Different philosophical assumptions highlight how and why the approaches to social research differ. This is not a text about the philosophy of science, but research methodology rests on a foundation of ontological and epistemological assumptions. Ontology dictates epistemology and both philosophies guide research methodology. Research methodology guides the selection of research methods.

Ontology

Ontology concerns the issue of what exists, or the fundamental nature of reality. When we do a study, we are making assumptions about what we will study and its place in the world. In simple words it is called theory of being in research.

Positions of Ontology in Research

There are two basic positions within ontology such as;

- Realist
- Nominalist

Realists position

Realists see the world as being “out there.” The world is organized into preexisting categories just waiting for us to discover. A realist assumes that the “real world” exists independently of humans and their interpretations of it. This makes accessing what is in the real world less difficult. To use a cliché, “What you see is what you get.” A subgroup of realists, critical realists, modify this assumption. They say that it is not easy to capture reality directly and that our inquiry into reality “out there” can easily become distorted or muddled. Our preexisting ideas, subjectivity, or cultural interpretations contaminate our contact with reality. The critical realist adds a few safeguards or adjustments to control the effect of such interpretations.

Nominalist Position

The nominalist assumes that humans never directly experience a reality “out there.” Our experience with what we call “the real world” is always occurring through a lens or scheme of interpretations and inner subjectivity. Subjective-cultural beliefs influence what we see and how we experience reality. Our personal biography and cultural worldview are always organizing our experiences into categories and patterns. They do this without our realizing it. Nominalists recognize that some interpretative schemes are more opaque than others, yet they hold that we can never entirely remove the interpretative lens. We are always limited in how far we can reach beyond our inner thoughts, cultural background, and subjectivity.

Distinction between Realist and the Nominalist Position

Let us make this abstract distinction between realists and nominalists more concrete with help of example. A realist sees a rug. She says reality presents her a rug—something to cover a floor and walk upon. She looks at a person’s facial features, hair, and skin tone and recognizes that the person belongs to one of the world’s racial groupings. She examines a person’s body in depth—such as skeleton, genitals, breasts, results of chemical tests for hormones, and hair coverage—and sees that the person is a biological male or female.

By contrast, a nominalist looks at a rug and asks what this might be. He asks what is it made of, how was it created, in what ways is it used, why is it here, and how does a specific historical cultural setting and people's practices with it shape what we see. Is it only something to wipe his feet on and walk upon? Do some people sit, sleep, and eat on the rug all day? Do people hang it on walls to keep a room warm? Can it be a work of art to be admired and provide aesthetic pleasure? Do people see the rug as a religious object and worship it? When the nominalist sees a person's skin tone and facial features, he is perplexed. Why are there categories of racial distinction? What might such categories contain when the entire idea of race varies greatly by culture and historical era? Likewise, a nominalist looks at a human body and worries about ambiguities in the physical differences. Is everyone clearly one or another of the biological sexes? How well do biological-physical differences match the gender-social differences of a society? As with racial categories, the number of gender categories and what distinguishes one from another varies greatly by culture and era. What a nominalist sees largely comes from imposing a subjective viewpoint onto the visible physical appearances, and what other people might see could be very different. We can put realist-nominalist ontological assumptions on a continuum (see Figure 1).

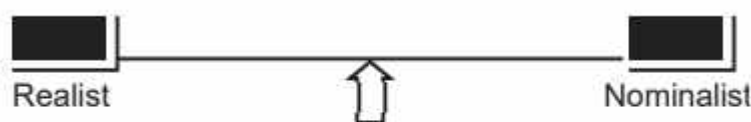


FIGURE 1 Ontological Assumptions

A hardcore realist says we see what exists, and we can easily capture it to produce objective knowledge. A critical realist is more cautious and recognizes that subjective-culture interpretations may color some of our experiences with reality. A moderate Ontology An area of philosophy that deals with the nature of being, or what exists; the area of philosophy that asks what really is and what the fundamental categories of reality are. Nominalist says subjective-cultural factors greatly shape all of our experiences with the physical and social world, and we can never totally remove such factors. An extreme nominalist says our basic understanding of every physical-social experience is depends so heavily on interpretative-cultural factors that the experiences make no sense without these factors and any form of objective knowledge is impossible.

Epistemology

Epistemology is 'a way of understanding and explaining how we know what we know', (Crotty, 2003:3). Epistemology is also 'concerned with providing a philosophical grounding for deciding what kinds of knowledge are possible and how we can ensure that they are both adequate and legitimate.' In simple words it is called theory of knowledge in research.

Positions of Epistemology in Research

There are two epistemological position in research

- Positivism
- Constructionism

Positivism

Positivism seeks to explain and predict what happens in the social world by searching for patterns and relationships. There is single reality in the universe and can be measured. Hypothesis are developed and tested. If we adopt a positivist position, we can produce

knowledge and learn about reality by making careful observations of it. A positivist standpoint says there is an empirical world “out there” that exists apart from our inner thoughts and perceptions of it. As we gather empirical evidence we find that some of our ideas about reality can be verified or found consistent with the evidence, while other ideas are false because they lack supporting empirical evidence.

Constructionism

There is no single reality and truth therefore reality needs to be interpreted. If we adopt a Constructionist position, making observations will not lead to knowledge about reality because interpretations and subjective views greatly influence all observations. The same holds true for people we might observe—their interpretations and subjective views shape all they say and do. What we and other people experience as reality is constructed from the outcome of a constant process of actions and interpretations that take place in particular locations and times. It is impossible to separate an objective “out there” reality from interpretations or effects of the time/place in which it occurs. The best we can do is to recognize our own viewpoints and interpretations. We might try to discover other people’s inner, subjective views and interpretations as they carry out their daily lives. General laws of social life, laws that hold across all people and places, are not possible to create. The best knowledge about the world that we can produce is to offer carefully considered interpretations of specific people in specific settings. We can offer interpretations of what we think other people are doing and what we believe to be their reasons in specific settings. To produce social science knowledge, we must inductively observe, interpret, and reflect on what other people are saying and doing in specific social contexts while we simultaneously reflect on our own experiences and interpretations.

Axiology

Axiology is an objective format for measuring intangible attitudes and values. Measures the level of development and the types of one’s perceptual biases in one’s thinking. In simple words it is called theory of values in research.

Positions of Axiology in Research

There are two Axiology position in research

- Value free
- Value laden

Value free

Value free contends that researcher can conduct research without the imposition of values.

Value laden

Value laden contends this is simply impossible.

What is Philosophy?

All research is based on assumptions about how the world is perceived and how we can best come to understand it. Nobody really knows how we can best understand the world. Philosophers have been arguing about it for 1000s of years. For us, as researchers, need to consider how we know about the world around us. What is our philosophical approach to knowledge?

Research Philosophy

Research philosophy is an over-arching term relating to the development of knowledge and the nature of that knowledge.

Types of Research Philosophies

Within the scope of Sociology in particular there are four main research philosophies:

- Positivism (Reality)
- Realism (objects exists independently of our knowledge)
- Interpretivism (Understand the difference between humans in their role as social actors)
- Pragmatism (Arguing that it is possible to work within both positivist & interpretivist)

	Positivism	Realism	Interpretivism	Pragmatism
Ontology: <i>the researcher's view of the nature of reality or being</i>	External, objective and independent of social actors	Is objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist)	Socially constructed, subjective, may change, multiple	External, multiple, view chosen to best enable answering of research question
Epistemology: <i>the researcher's view regarding what constitutes acceptable knowledge</i>	Only observable phenomena can provide credible data, facts. Focus on causality and law like generalisations, reducing phenomena to simplest elements	Observable phenomena provide credible data, facts. Insufficient data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations which are open to misinterpretation (critical realism). Focus on explaining within a context or contexts	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions	Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question. Focus on practical applied research, integrating different perspectives to help interpret the data
Axiology: <i>the researcher's view of the role of values in research</i>	Research is undertaken in a value-free way, the researcher is independent of the data and maintains an objective stance	Research is value laden; the researcher is biased by world views, cultural experiences and upbringing. These will impact on the research	Research is value bound, the researcher is part of what is being researched, cannot be separated and so will be subjective	Values play a large role in interpreting results, the researcher adopting both objective and subjective points of view
Data collection techniques most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative	Methods chosen must fit the subject matter, quantitative or qualitative	Small samples, in-depth investigations, qualitative	Mixed or multiple method designs, quantitative and qualitative

Comparison between Research Philosophies in Sociology

Empiricism

In philosophy, empiricism is a theory that states that knowledge comes only or primarily from sensory experience. It is one of several views of epistemology, along with rationalism and

skepticism. Empiricism emphasizes the role of empirical evidence in the formation of ideas, rather than innate ideas or traditions. The major shift in scientific thought occurred during the 16th century, when British philosopher Francis Bacon (1561-1626) suggested that knowledge can only be derived from observations in the real world. Based on this premise, Bacon emphasized knowledge acquisition as an empirical activity (rather than as a reasoning activity), and developed **empiricism** as an influential branch of philosophy. Bacon's works led to the popularization of inductive methods of scientific inquiry, the development of the "scientific method" (originally called the "Baconian method"), consisting of systematic observation, measurement, and experimentation, and may have even sowed the seeds of atheism or the rejection of theological precepts as "unobservable." Empiricism continued to clash with rationalism throughout the Middle Ages, as philosophers sought the most effective way of gaining valid knowledge.

Conclusion

The quantitative research opt realist ontological position, positivist epistemological standpoint and value free axiological position in research. The research philosophy of the quantitative research is Positivism and Post positivism.

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- Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.
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Lesson 04**POSITIVIST SOCIAL RESEARCH AND ITS MAJOR ASSUMPTIONS****Topic 004: Positivist Social Research and its Major Assumptions****History of Positivist Social Research**

Positivism believes the basis for knowledge and thought should depend on the scientific method. It was introduced by Auguste Comte, a French philosopher who coined the term “positivism.” The positivist does not derive conclusions from a subjective approach and does not let feelings and emotions cloud his judgment because these things are in the person’s consciousness. The consciousness, Comte inferred, cannot be objectively observed. Positivism has been a dominant paradigm in social science, especially as practiced in the United States since 1945. Positivism was the dominant epistemological paradigm in social science from the 1930s through to the 1960s, its core argument being that the social world exists externally to the researcher, and that its properties can be measured directly through observation. Anthropology and history are the least positivist fields and economics and experimental psychology the most positivist with political science and sociology somewhat mixed. Several paradigms compete in sociology, but it “has been Paradigm A general organizing framework for theory and research that includes basic assumptions, key issues, models of quality research, and methods for seeking answers. Predominantly positivist since 1945, aside from a brief period of epistemological turmoil . . .” (Steinmetz, 2005a:25).

Introduction

Positivism tries to uncover the one truth about how things are – or at least what we focus on. It is defined as a system recognizing only that which can be scientifically verified or logically proved, and therefore rejecting metaphysics and theism’ (Oxford, 1989: pp. 385-386)

Positivism argues that reality consists of what is available to the senses – that is, what can be seen, smelt, touched, etc. Inquiry should be based upon scientific observation and empirical inquiry. The natural and human sciences share common logical and methodological principles, dealing with facts and not with values. A structured method, combining logical deduction with precise empirical (well known) observations (of the behavior of individuals). To open up and confirm causal relationships that are generally valid with a known probability and which can therefore be used for prediction. The purpose of science is to uncover the truth & make it to be able to control and predict. Humans are expected to be rational. Objectivity and precision is important. Therefore measurement and measures, tools and procedures are very important. Because reality is stable and truths are generally valid.

Main Assumptions of positivism

Positivism is a philosophy that holds that empirical evidence obtained through the senses is the only firm foundation for knowledge. Further, it insists that valid knowledge can only be assumed if all observers come up with essentially the same description of a thing. Last, it requires that these descriptions be uniform across all researchers or observers, which leads to the requirement that measurement is the royal road to knowledge. Thus, positivism leads to the following four sets of assumptions:

- **Ontological assumptions (nature of reality):** There is one defined reality, fixed, measurable, and observable.
- **Epistemological assumptions (knowledge):** Genuine knowledge is objective and quantifiable. The goal of science is to test and expand theory.

- **Axiological assumptions (role of values):** Objectivity is good, and subjectivity is inherently misleading.
- **Methodological assumptions (research strategies):** Using quantitative research methods such as experiments, quasi-experiments, exploratory and analytical models, case studies, and so on—which require objective measurement and analysis—is the only acceptable method to generate valid knowledge.

As should be obvious, such assumptions lead to quantitative studies, which rely on objective measurement of observable phenomena. That which cannot be measured cannot be reliably known.

Positivistic Research Study Example:

In 2012 Venkatesh, Thong and Xu published their article, "Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology," examining consumer acceptance and use of information technology. (If you wish to review the entire article, it is linked in the Track 2 Courseroom Resources section.) Venkatesh, Thong and Xu made the following assumptions:

- **Ontological assumption:** Consumer acceptance and use of information technology can be observed and measured. There is one defined reality for these constructs and if measured, will be readily visible to all who observe it.
- **Epistemological assumption:** The acquisition of knowledge of consumer acceptance and use of information technology is an objective process, one that can be measured, and that measured and objective report is reliable and useful knowledge.
- **Axiological assumption:** The measurements for consumer acceptance and information technology will objectively inform the theory of acceptance and use of technology, which is a valuable to understand.
- **Methodological assumption:** Quantitative design—A new survey instrument was adapted from the Unified Theory of Acceptance and Use of Technology (UTAUT)—a four input construct model of performance expectancy, effort expectancy, social influence and facilitating conditions which influence behavioral intentions of use (Venkatesh et al., 2003). Additional existing scales were also adapted to measure variables of hedonic motivation, price value, and habit with moderating variables of age, gender and experience. After a pilot study, a two-stage online survey was conducted to explain behavioral intention and the subsequent mobile use behavior. The measurement and structural models were tested using Partial Least Squares to create UTAUT2.

Key Features of Positivism

The key features of the Positivism enlisted below;

- It is concerned with the search for the unification of scientific method, that is, with the notion that logic and inquiry are universal principles extending across all scientific domains.
- That the ultimate end of scientific inquiry is to give explanations of social phenomenon and to make predictions about their behavior as according to discernable laws of society. Thus positivism in the social sciences seeks also to develop a 'general law of social understanding', by discovering necessary and sufficient conditions for any phenomenon.
- Positivism maintains that social scientific knowledge must always be subject to proof through empirical experimentation. All subjects of research and investigation in the social sciences should be based upon observations derived from sense-perceptions.

- Social sciences must seek to free themselves of value-judgments as far as possible, and of moral, political, and religion ideas that might contaminate their research. Thus, in short: social sciences must seek to discover universal conditions behind social phenomena; all social scientific empirical statements must be absolute truths which are true at all times and true in all places; finally, research can be proved only by empirical experimentation.
- Positivists also believe that sociology can and should use the same methods and approaches to study the social world that “natural” sciences such as biology and physics use to investigate the physical world. By adopting “scientific” techniques sociologists should be able, eventually, to uncover the laws that govern societies just as scientists have discovered the laws that govern the physical world.
- In positivist research, sociologists tend to look for relationships, or ‘correlations’ between two or more variables. This is known as the comparative method

Positivist use of Quantitative Research

- Use it to uncover & measure patterns of behavior.
- Produce precise mathematical statements about the facts they are investigating.
- Seek to discover the laws of cause & effect that determine behavior.
- Research should be detached & objective.
- Positivist researchers should check their subjective feelings, values or prejudices at the door as it can affect their research & findings.

Positivist Perspective	
Independence	The observer is independent of what is being observed.
Value-freedom	The choice of what to study, and how to study it, can be determined by objective criteria rather than by human beliefs and interests.
Causality	The aim of social science should be to identify causal explanations and fundamental laws that explain regularities in human social behaviour.
Hypothetico-deductive	Science proceeds through a process of hypothesising fundamental laws and then deducing what kinds of observations will demonstrate the truth or falsity of these hypotheses.
Operationalisation	Concepts need to be operationalised in a way which enables facts to be measured quantitatively; static design – categories isolated before study.
Reductionism	Problems as a whole are better understood if they are reduced into the simplest possible elements.
Generalisation	In order to be able to generalise about regularities in human and social behaviour it is necessary to select samples of sufficient size; aim of generalisations is to lead to prediction, explanation and understanding.
Research Language	Formal, based on set definitions; impersonal voice; use of accepted quantitative words.

Advantage of Positivist Social research

Positivism relies on quantitative data that positivists believe is more reliable than qualitative research. Quantitative research is more “scientific” in its methods than qualitative research and thus more trustworthy. In research, quantitative data provides objective information that researchers can use to make scientific assumptions. Positivism follows a well-defined structure during studies and discussions. Positivists believe that since there are set laws and rules followed, there will be minimum room for error. This structure also gives little room for variance and drastic variable changes, thus making the study more accurate when it comes to experiments and applications as it tries to follow specific rules using objective mathematical and scientific tools.

Disadvantage of Positivist Social research

Positivism believes that objective inferences and conclusions can be reached as long as the person doing the observation is objective and disregards her emotions. However, human behavior naturally comes with emotional responses. Although positivism encourages researchers to disregard human emotion and behavior, there is no guarantee that this will occur at all times during studies. Some scholars believe that since positivists believe everything can be measured and calculated, they tend to be inflexible. Positivists see things as they are and tend to disregard unexplained phenomena. If a theory that says A only occurs when B and C combine, then B can never be A. This belief can eliminate lateral thinking, which is the process of finding answers by creatively and indirectly finding out ways to solve a problem.

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Lesson 5**THEORY AND RESEARCH-I****Topic 005: Theory and Research****Introduction**

A Theory is a set of interrelated concepts used to describe, explain, and predict how society and its parts are related to each other. Theories are sets of interrelated concepts and ideas that have been scientifically tested and combined to clarify, and expand our understanding of people, their behaviours, and their societies. Without theories, science would be a futile exercise. A theory is a set of propositions that provide an explanation by means of a deductive or inductive system. The three major functions of theory are description, explanation and prediction.

WHAT IS THEORY?

Social theory is a system of interconnected ideas. It condenses and organizes knowledge about the social world. We can also think of it as a type of systematic “story telling” that explains how some aspect of the social world works and why. Many courses in social theory emphasize the history of social thought or teach us what great thinkers said. Classical social theorists (e.g., Durkheim, Marx, Mills, Tonnies, and Weber) generated many innovative ideas. They radically changed how we see and understand the social world around us by developing highly original, broad theories that laid the foundation for subsequent generations. We continue to study their writings because they offered many creative and interrelated ideas. Such true geniuses who can generate many insightful ideas and fundamentally shift how we see the social world are very rare. Despite the value of their contributions, theory is more than what the classical social theorists wrote. It is also more than we learn from recent leading theorists (e.g., Jeffrey Alexander, Pierre Bourdieu, James Coleman, Michel Foucault, Anthony Giddens, and Erving Goffman). Although theorists generate many new ideas and theories, we all can use theory.

Theories are not static. We are constantly modifying older theories and developing new ones. Theories come in many shapes and sizes. Some are broad systems of thought while others are narrow and specific explanations of one particular issue. At their core, we use social theories to organize and systematize our thinking and to deepen and extend understanding. Because they organize knowledge, theories also become a way to communicate effectively with one another. Most likely, we all encounter social theories in daily life, although few are explicit or labeled as such. For example, newspaper articles or television reports on social issues usually rely on implicit social theories or partial theories. Such theories may be shallow and incomplete, but they contain assumptions, interconnected concepts, and explanations.

Nature of Theory

A theory is a proposed relationship between two or more concepts. In other words, a theory is explanation for why a phenomenon occurs. Without theories to explain the relationship between concepts, we would not be able to understand cause and effect relationships in social life.

Characteristics of Theory

The major characteristics of theory are given below.

- **Time boundedness:** Scientific theories always seek to transcend the particular and the time bound. Scientific theories are therefore about the generic, the fundamental, the timeless, and the universal.

- **Objectivity:** Another characteristic of scientific theories is that they are stated more formally than ordinary language. Theory is stated in neutral, objective, and unambiguous terms so that the theory means the same thing to all who examine it.
- **Reliability and Verifiability:** A final characteristic of scientific theories is that they are designed to be systematically tested with replicable methods against the facts of particular empirical settings.

Elements of theory

Theory is a mental activity revolving around the process of developing ideas that explain how and why events occur. Theory is constructed with the following basic elements or building blocks:

- (1) Concepts
- (2) Variables
- (3) Statements
- (4) Formats.

Though there are different types of theory, the basic elements are common to all.

1. Concepts

Theories are built from concepts. Generally, concepts denote phenomena. A concept embraces the aspects of the social world that are considered essential for a particular purpose. Concepts are constructed from definitions. A definition is a system of terms that inform investigators as to the phenomenon denoted by a concept. A definition allows visualising the phenomenon that is denoted by the concept. It enables all investigators to see the same thing and to understand what it is that is being studied. Thus, concepts that are useful in building theory have a special characteristic: they strive to communicate a uniform meaning to all those who use them. However, since concepts are frequently expressed with the words of everyday language, it is difficult to avoid words that connote varied meanings—and hence point to different phenomena—for varying groups of scientists. It is for this reason that many concepts in science are expressed in technical or more neutral languages, such as the symbols of mathematics. In sociology, expression of concepts in such special languages is sometimes not only impossible but also undesirable. Hence the verbal symbols used to develop a concept must be defined as precisely as possible so that they point to the same phenomenon for all investigators. Although perfect consensus may never be attained with conventional language, a body of theory rests on the premise that scholars will do their best to define concepts unambiguously. The concepts of theory reveal a special characteristic: abstractness. Some concepts pertain to concrete phenomena at specific times and locations. Other, more abstract, concepts point to phenomena that are not related to concrete times or locations.

For example, in the context of small-group research, concrete concepts would refer to the persistent interactions of particular individuals, whereas an abstract conceptualization of such phenomena would refer to those general properties of face-to-face groups that are not tied to particular individuals interacting at a specified time and location. Whereas abstract concepts are not tied to a specific context, concrete concepts are. Although it is essential that some of the concepts of theory transcend specific times and places, it is equally critical that there be procedures for making these abstract concepts relevant to observable situations and occurrences. The utility of an abstract concept can be demonstrated only when the concept is brought to analyse some specific empirical problem encountered by investigators; otherwise, concepts remain detached from the very processes they are supposed to help investigators

understand. Some argue for very formal procedures for attaching concepts to empirical events. Those of this view believe that abstract concepts should be accompanied by a series of statements known as operational definitions, which are sets of procedural instructions telling investigators how to go about discerning phenomena in the real world that are denoted by an abstract concept. Others argue, however, that the nature of our concepts in sociology precludes such formalistic exercises. At best, concepts can be only devices that must change with the changes in society, and so we can only intuitively and provisionally apply abstract concepts to the actual analysis.

2. Variables

Once the measurement system has been specified by the operational definition, different values of the concept can be observed. The concept can now be referred to as a variable, since it can respond to differences in the “real world” by taking on varying values, as specified in the operational definition. When used to build theory, two general types of concepts can be distinguished: (1) those that simply label phenomena and (2) those that refer to phenomena that differ in degree. Concepts that merely label phenomena would include such common terms like group, social class etc. Concepts that denote properties as size, weight, density, velocity etc. refer to differences in degree among phenomena. Some concepts of scientific theory should denote the variable features of the world. To understand events it is necessary to analyse how variation in one phenomenon is related to variation in another.

3 &4. Statements and Formats

To be useful, the concepts of theory must be connected to one another. Such connections among concepts constitute theoretical statements. These statements specify the way in which events denoted by concepts are interrelated, and at the same time, they provide an interpretation of how and why events should be connected. When these theoretical statements are grouped together, they constitute a theoretical format. Concepts are constructed from definitions; theoretical statements link concepts together; and statements are organized into five basic types of formats.

There are five basic approaches in sociological theory for generating theoretical statements and formats: (1) metatheoretical schemes, (2) analytical schemes, (3) discursive schemes, (4) propositional schemes, and (5) modeling schemes.

1. Meta-theoretical schemes

Meta-theoretical schemes deal with the basic issues that a theory must address. In many sociological circles, meta-theory is considered an essential prerequisite to adequate theory building. The philosophical debates like idealism versus materialism, induction versus deduction, causation versus association, subjectivism versus objectivism, and so on are re-evoked and analyzed with respect to social reality.

2. Analytical Scheme

Analytical Scheme is a classification scheme that denotes the key properties, and interrelations among these properties, in the social universe. There are many different varieties of analytical schemes, but they share an emphasis on classifying basic properties of the social world. Explanation of an empirical event comes whenever a place in the classificatory scheme can be found for an empirical event. There are two basic types of analytical schemes: (1) naturalistic schemes, which try to develop a tightly woven system of categories that is presumed to capture the way in which the invariant properties of the universe are ordered and (2) sensitizing schemes, which are more loosely assembled congeries of concepts intended only to sensitize and orient researchers and theorists to certain critical processes.

3. Discursive Schemes

Discursive Schemes are typically easier to understand than those that are more formal, but the weakness is that the variables and forces highlighted and the dynamic relations among them are vague and imprecise. Even with a certain vagueness in language, it is still possible to recognise the basic theoretical argument and convert it into a more formal format like an analytical model or propositions scheme.

4. Propositional Scheme

Propositional Scheme is a theoretical statement that specifies the connection between two or more variables. It tells us how variation in one concept is accounted for by variation in another. Propositional Schemes vary perhaps the most of all theoretical approaches. They vary primarily along two dimensions: (1) the level of abstraction and (2) the way propositions are organized into formats. Some are highly abstract and contain concepts that do not denote any particular case but all cases of a type. By using these two dimensions, several different types of propositional schemes can be isolated: (a) axiomatic formats, (b) formal formats, and (c) empirical formats.

Axiomatic Formats

An axiomatic organization of theoretical statements involves a set of concepts some of which are concepts are highly abstract; others, more concrete. Second, there is always a set of existence statements that describe those types and classes of situations in which the concepts and the propositions that incorporate them apply. Third, propositional statements are stated in a hierarchical order. At the top of the hierarchy are axioms, or highly abstract statements, from which all other theoretical statements are logically derived. The axioms should be consistent with one another, although they do not have to be logically interrelated. The axioms should be highly abstract; they should state relationships among abstract concepts. These relationships should be law-like in that the more concrete theorems derived from them have not been disproved by empirical investigation.

Formal Formats

Formal theories are loose versions of axiomatic schemes. The idea is to develop highly abstract propositions that are used to explain some empirical event. Some highly abstract propositions are seen as higher-order laws, and the goal of explanation is to visualize empirical events as instances of this covering law. Deductions from the laws are made, but they are much looser, rarely conforming to the strict rules of axiomatic theory. Moreover, there is recognition that extraneous variables cannot always be excluded, and so the propositions have a condition that if other forces do not impinge, then the relationship among concepts in the proposition should hold true.

Empirical Formats

Empirical Formats consist of generalizations from specific events, in particular empirical contexts. They are too tied to empirical contexts, times, and places. In fact, they are generalizations that are in need of a theory to explain them. There are other kinds of empirical generalizations also. These are often termed middle-range theories, because they are more abstract than a research finding and because their empirical content pertains to variables that are also found in other domains of social reality.

5. Analytical Modeling Scheme

Analytical Modeling Scheme is a diagrammatic representation of social events. The diagrammatic elements of any model include: (1) concepts that denote and highlight certain

features of the universe; (2) the arrangement of these concepts in visual space so as to reflect the ordering of events in the universe; and (3) symbols that mark the connections among concepts, such as lines, arrows, vectors, and so on. The elements of a model may be weighted in some way, or they may be sequentially organized to express events over time, or they may represent complex patterns of relations and other potential ways in which properties of the universe affect one another. In sociology, most diagrammatic models are constructed to emphasize the causal connections among properties of the universe. That is, they are designed to show how changes in the values of one set of variables are related to changes in the values of other variables. Sociologists generally construct two different types of models, which can be termed analytical models and causal models. Analytical models are more abstract: they highlight more generic properties of the universe, and they portray a complex set of connections among variables. In contrast, causal models are more empirically grounded. They provide a more detailed interpretation of an empirical generalization.

Ideology versus Social Theory

Social Theory versus Ideology

BASIS OF DIFFERENCE	IDEOLOGY	THEORY
Certainty of answers	Absolute, certain answers with few questions	Tentative, conditional answers that are incomplete and open ended
Type of knowledge	Closed, fixed belief system	Open, expanding belief system
Type of assumptions	Implicit assumptions based on faith, moral belief, or social position	Explicit, changing assumptions based on open, informed debate and rational discussion
Use of normative statements	Merger of descriptive claims, explanations, and normative statements	Separation of descriptive claims, explanations, and normative statements
Empirical evidence	Selective use of evidence, avoidance of direct tests of claims, resistance, denial, or ignorance of contrary evidence	Consideration of all evidence, seeking repeated tests of claims, changing, based on new evidence
Logical consistency	Contradictions and logical fallacies	Highest levels of consistency and congruity, avoiding logical fallacies
Transparency	Avoidance of transparency	Encouragement of transparency

Example Ideology versus Social Theory

Explaining Divorce

How an Ideology Might Explain Divorce

American society has experienced a moral-social breakdown over the past 30 years. Families were strong, mothers did not work away from home but spent much more time taking care of their children and husband. Because of religious and moral teachings, families were strong, and divorce was rare. In the recent decades, however, moral decay has spread. There is less respect for religious and moral authority. Negative behaviors, government policy, and mass media have weakened the family and caused divorce to increase.

An Evaluation This explanation uses the concepts of *moral-social breakdown*, *strength of family*, *divorce*, *time that mothers spend with their children and husband*, *moral decay*, *loss of respect*, and *media messages*. These concepts lack precise meanings and measurement, and their exact timing is not certain. The concepts are vague and highly evaluative (e.g., *decay*, *breakdown*, *bad*). Testing the explanation would not be easy, and a long time frame suggests that alternative factors occurred in the same period that also might have an impact.

Example of Social Theory

Whether or not a family remains intact (i.e., married adults do not divorce) and is strong (i.e., expresses

affection toward one another and spends time together, devotes more time nurturing children, exhibits positive social interaction patterns) depends on the level of resources and social-emotional stress. Resources include factors that are material (income, education, housing), social (friends and extended family, involvement in community organizations), cognitive (e.g., schooling, knowledge, following current events), and psychological (positive self-images, maturity, and respect for others). Stress includes uncertainty about the future and instability of life conditions (e.g., irregularly employed family members, poor or declining health, victims of crime, or emotional instability). Families with both sufficient resources and low levels of stress tend to be stronger than those with a combination of low resources and high stress, and strong families are more likely to remain intact than weak families.

An Evaluation This explanation uses four concepts: *resources* (three types), *stress*, *family strength*, and *remaining intact*. It suggests definitions or how we measure each concept. The relationship among concepts is straightforward and can be empirically tested.

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Lesson 06**THEORY AND RESEARCH-II****TOPIC 006****Topic 006: Theory and Research****Aspects of Theory**

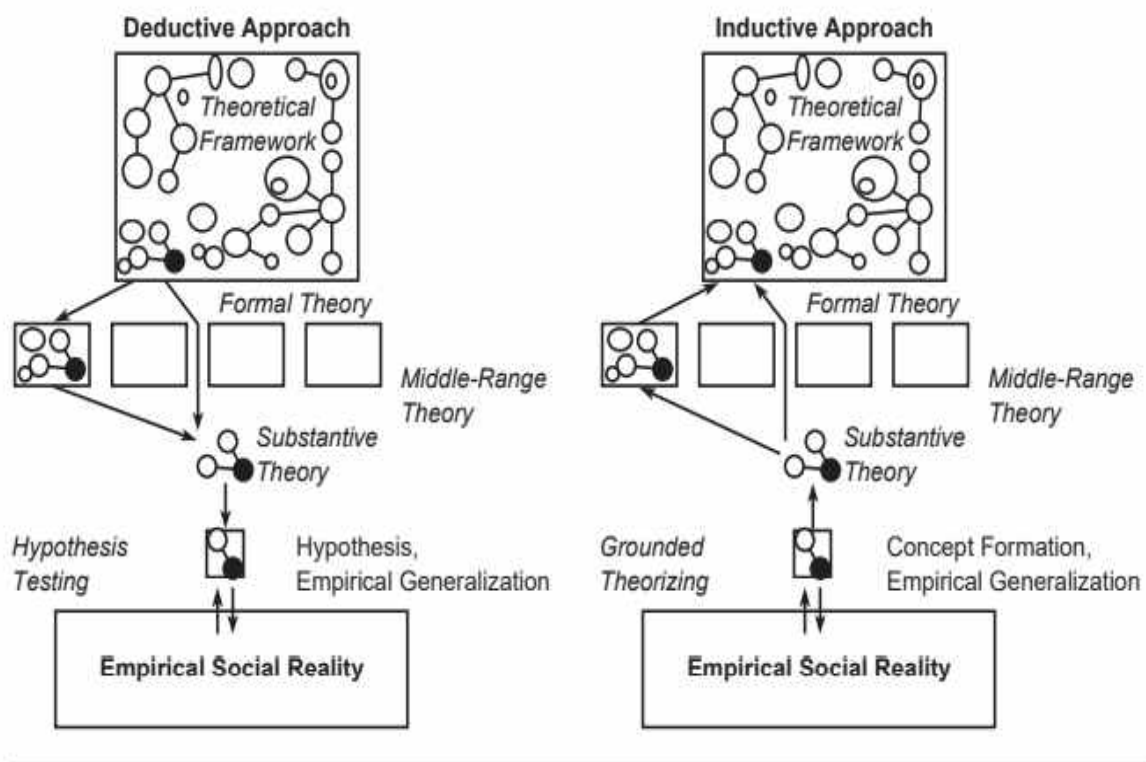
Now that you know the parts of social theory, you can consider its other forms. Social theory can be baffling because it has many aspects. To simplify matters, we can divide them into five major ones:

- 1. Direction of theorizing.** Either deductive or inductive
- 2. Level of analysis.** Either micro, macro, or meso
- 3. Theoretical focus.** Either substantive or formal theory
- 4. Form of explanation.** Either causal, structural, or interpretative
- 5. Range of a theory.** Either an empirical generalization, a middle-range theory, or a framework

1. Direction of Theorizing

In an ideal sense, you can approach the building and testing of theory from two directions:

- 1) Begin with abstract thinking and then logically connect the ideas in theory to concrete evidence (2) Begin with specific observations of empirical evidence and then generalize from the evidence to build toward increasingly abstract ideas. In practice, most researchers are flexible and tend use both directions, perhaps at different points in a study.



Inductive theory

Inductive theory is an approach to research that starts with the observation and the end result of the research is theory.

Deductive theory

Deductive theory is an approach to research that starts with the proposition of hypothesis and the end result of the research is Confirmation/rejection.

Abduction

The third method of reasoning, *abduction*, is defined as "a syllogism in which the major premise is evident but the minor premise and therefore the conclusion only probable." Basically, it involves forming a conclusion from the information that is known.

A familiar example of abduction is a detective's identification of a criminal by piecing together evidence at a crime scene. In an everyday scenario, you may be puzzled by a half-eaten sandwich on the kitchen counter. Abduction will lead you to the best explanation. Your reasoning might be that your teenage son made the sandwich and then saw that he was late for work. In a rush, he put the sandwich on the counter and left.

2. Level of analysis.

Micro-level theory Social theory

Micro-level theory Social theory focusing on the micro level of social life that occurs over short durations (e.g., face-to-face interactions and encounters among individuals or small groups).

Macro-level theory Social theory

Macro-level theory Social theory focusing on the macro level of social life (e.g., social institutions, major sectors of society, entire societies, or world regions) and processes that occur over long durations (many years, multiple decades, or a century or longer).

Meso-level theory Social theory

Meso-level theory Social theory focusing on the relations, processes, and structures at a midlevel of social life (e.g., organizations, movements, and communities) and events operating over moderate durations (many months, several years, or a decade).

3. Theoretical focus

Substantive theory

Substantive theory focuses on a particular content or topic area in social reality, such as family relations, delinquent behavior, or racial-ethnic relations. We might have a theory that focuses on economic development as with Mahoney's (2003) study of Spanish America or a theory that focuses on how social inequalities are reproduced in everyday face-to-face interactions as with Williams' (2006) study of toy stores.

Formal theory

Formal theory focuses on general processes or structures that operate across multiple topic areas, such as forming a social identity, engaging in conflict, or exercising power. It is more general and abstract. A formal theory about access to resources and holding onto power and authority might apply to several areas. It might explain how wealthy business owners use their

access to valued resources in advanced capitalist societies to maintain economic and social power, how government elites used resource control to try to hold onto power during the transition from communism to a post community world, and how colonial elites in a rigid system of resource control held onto local power in the nineteenth century in a way that stalled later national development. In all three situations, a similar social-economic dynamic operated: Powerful elite groups used their ownership and control over valued resources to maintain a position of power and resist challenges to their authority.

4. Form of explanation.

1. Causal explanation

A type of theoretical explanation about why events occur and how things work expressed in terms of causes and effects or as one factor producing certain results.

Negative relationship

An association between two concepts or measures so that as one increases, the other decreases, or when one is present, the other is absent.

Positive relationship

An association between two concepts or measures so that as one increases, the other also increases, or when one is present, the other is also present.

2. Structural explanation

A type of theoretical explanation about why events occur and how things work expressed by outlining an overall structure and emphasizing locations, interdependences, distances, or relations among positions in that structure.

3. Interpretative explanation

A type of theoretical explanation about why events occur and how things work expressed in terms of the socially constructed meanings and subjective worldviews.

5. Range of Theorizing

Theoretical statements also vary by range. At one extreme is the empirical generalization, a narrow statement that relies on concrete concepts and fits into a substantive theory; it is a low-level descriptive statement about a relationship believed to operate empirically. It generalizes beyond a specific case or set of observations but not by very much. For example, people who marry when they are very young (under age 21) are more likely to divorce than those who marry when they are older (over age 31). We might wish to qualify the generalization by specifying historical, cultural, or other conditions that make a divorce more or less likely. If empirical generalization includes an explanation, it is simple and concrete, not a full social theory. For example, people who marry when they are younger are more likely to divorce because they are less mature.

Middle-range theory Social theory

Middle-range theory Social theory that falls between general frameworks and empirical generalization, that has limited abstraction/range, and that is in the form of empirically verifiable statements capable of being connected to observable phenomena

Empirical generalization

A narrow, quasi-theoretical statement that expresses empirical patterns or describes empirical regularities using concepts that are not very abstract.

Theoretical framework

A very general theoretical system with assumptions, concepts, and specific social theories.

Role of Theory

1. Theory as orientation

A major function of a theoretical system is that it narrows the range of facts to be studied. Any phenomenon or object may be studied in many different ways. A football, for example, can be investigated within an economic framework, as we ascertain the patterns of demand and supply relating to this play object. It may also be the object of chemical research, for it is made of organic chemicals. It has a mass and may be studied as physical object undergoing different stresses and attaining certain velocities under various conditions. It may also be seen as the center of many sociologically interesting activities; play, communication, group organization, etc. Each science and each specialization within a broader field abstracts from reality, keeping its attention upon a few aspects of given phenomena rather than on all aspects. The broad orientation of each field then focuses upon limited range of things while ignoring or making assumptions about others.

2. Theory as a conceptualization and classification

Every science is organized by a structure of concepts, which refer to major processes and objects to be studied. It is the relationship between these concepts which are stated in “the facts of science.” Such terms make up the vocabulary that the scientist uses. If knowledge is to be organized, there must be some system imposed upon the facts which are observable. As a consequence, a major task in any science is the development of development of classification, a structure of concepts, and an increasingly precise set of definitions for these terms.

3. Theory in summarizing role

A further task which theory performs is to summarize concisely what is already known about the object of study. These summaries may be divided into two simple categories: (1) empirical generalizations, and (2) systems of relationships between propositions. Although the scientist may think of his field as a complex structure of relationships, most of his daily work is concerned with prior task: the simple addition of data, expressed in empirical generalizations. The demographer may tabulate births and deaths during a given period in order to ascertain the crude rate of reproduction. These facts are useful and are summarized in simple or complex theoretical relationships. As body of summarizing statements develops, it is possible to see relationships between the statements. Theorizing on a still larger scale, some may attempt to integrate the major empirical generalizations of an era. It is through systems of propositions that many of our common statements must be interpreted. Facts are seen within a framework rather than in an isolated fashion.

4. Theory predicts facts

If theory summarizes facts and states a general uniformity beyond the immediate observation, it also becomes a prediction of facts. This prediction has several facets. The most obvious is the extrapolation from the known to the unknown. For example, we may observe that in every known case the introduction of Western technology has led to a sharp drop in the death rate and a relatively minor drop in the birth rate of a given nation, at least during the initial stages. Thus we predict that if Western technology is introduced into a native culture, we shall find this process again taking place. Correspondingly we predict that in a region where Western technology has already been introduced, we shall find that this process has occurred.

5. Theory points gaps in knowledge

Since theory summarizes the known facts and predicts facts which have not been observed, it must also point to areas which have not yet been explored. Theory also points to gaps of a more basic kind. While these gaps are being filled, changes in the conceptual scheme usually occur. An example from criminology may be taken. Although a substantial body of knowledge had been built up concerning criminal behavior and its causes. A body of theory dealing with causation was oriented almost exclusively to the crimes committed by the lower classes. Very little attention has been paid to the crimes committed by the middle class or, more Research Methods specifically, to the crimes labeled as “white collar” and which grow out of the usual activities of businessmen. Such a gap would not be visible if our facts were not systematized and organized. As a consequence, we may say that theory does suggest where our knowledge is deficient.

Role of Facts (Research)

Theory and fact are in constant interaction. Developments in one may lead to developments in the other. Theory, implicit or explicit, is basic to knowledge and even perception. Theory is not merely a passive element. It plays an active role in the uncovering of facts. We should expect that “fact” has an equally significant part to play in the development of theory. Science actually depends upon a continuous stimulation of fact by theory and of theory by fact.

1. Facts initiate theory

Many of the human interest stories in the history of science describe how a striking fact, sometimes stumbled upon, led to important theories. This is what the public thinks of as a “discovery.” Examples may be taken from many sciences: accidental finding that the penicillium fungus inhibits bacterial growth; many errors in reading, speaking, or seeing are not accidental but have deep and systematic causes. Many of these stories take an added drama in the retelling, but they express a fundamental fact in the growth of science, that an apparently simple observation may lead to significant theory.

2. Facts lead to the rejection and reformulation of existing theory

Facts do not completely determine theory, since many possible theories can be developed to take account of a specific set of observation. Nevertheless, facts are the more stubborn of the two. Any theory must adjust to facts and is rejected or reformulated if they cannot be fitted into its structure. Since research is continuing activity, rejection and reformulation are likely to be going on simultaneously. Observations are gradually accumulated which seem to cast doubt upon existing theory. While new tests are being planned, new formulations of theory are developed which might fit these new facts.

3. Facts redefine and clarify theory. Usually the scientist has investigated his/her problem for a long time prior to actual field or laboratory test and is not surprised by his/her results. It is rare that he/she finds a fact that simply does not fit prior theory. New facts that fit the theory will always redefine the theory, for they state in detail what the theory states in very general terms. They clarify that theory, for they throw further light upon its concepts.

Theory and Research: the Dynamic Duo

Theory and research are interrelated; the dichotomy between theory and research is an artificial. The value of theory and its necessity for conducting good research should be clear. Researchers who proceed without theory rarely conduct top-quality research and frequently find themselves in confusion. Researchers weave together knowledge from different studies into more abstract

theory. Likewise, who proceed without linking theory to research or anchoring it to empirical reality are in jeopardy of floating off into incomprehensible speculation and conjecture.

References

Neumann, L. (2014). *Social Research Methods: Qualitative and Quantitative Approaches*. Seven Edition. Pearson.

Lesson 07**THEORETICAL FRAMEWORK IN QUANTITATIVE RESEARCH****Topic 007: Theoretical Framework in Quantitative Research****Theoretical framework**

The theoretical framework is the structure that can hold or support a theory of a research study. The theoretical framework introduces and describes the theory which explains why the research problem under study exists. A very general theoretical system with assumptions, concepts, and specific social theories. Theoretical frameworks are at the widest range and the opposite extreme from empirical generalizations. A theoretical framework is more than a formal or substantive theory and includes many specific formal and substantive theories that may share basic assumptions and general concepts in common. Sociology has several major frameworks. They are orientations or sweeping ways to see and think about the social world. They provide assumptions, concepts, and forms of explanation. For example, each framework may have its own theory of the family, of crime, or of social change. Some frameworks (e.g., symbolic interactionism) are more oriented toward the micro level of analysis whereas others (e.g., conflict) are stronger at the macro level. Specific studies rarely test or contrast entire frameworks. More often, studies seek evidence for one part of a theory within one framework (e.g., one proposition from a conflict theory of crime).

Example

Kalmijn's Levels of Theory, illustrates the ranges of theory with Kalmijn's study of changing marriage partner selection. Each framework is associated with an overall approach to doing research.

Kalmijn's Levels of Theory in "Shifting Boundaries"

Theoretical framework. Structural functionalism holds that the processes of industrialization and urbanization change human society from a traditional to a modern form. In this process of modernization, social institutions and practices evolve. This evolution includes those that fill the social system's basic needs, socialize people to cultural values, and regulate social behavior. Institutions that filled needs and maintained the social system in a traditional society are superseded by modern ones.

Formal theory. Secularization theory says that during modernization, people shift away from a reliance on traditional religious beliefs and local community ties. In traditional society, institutions that conferred ascribed social status (family, church, and community) also controlled socialization and regulated social life. In modern society, they are superseded by secular institutions (e.g., education, government, and media) that confer achievement-oriented status.

Middle-range substantive theory. A theory of intermarriage patterns notes that young adults in modern society spend less time in small, local settings where family, religion, and community all have a strong influence. Instead, young adults spend increasing amounts of time in school settings. In these settings, especially in college, young adults have opportunities to meet other unmarried people. In modern society, education has become a major socialization agent. It affects future earnings, moral beliefs and values, and leisure interests. Thus, young adults select marriage partners less on the basis of shared religious or local ties and more on the basis of common educational levels.

Empirical generalization. Americans once married others with similar religious beliefs and affiliation. This practice is being replaced by marriage to others with similar levels of education.

The Components of the Theoretical Framework

A good theoretical framework identifies and labels the important variables in the situation that are relevant to the problem identified. It logically describes the interconnections among these variables. The relationships among the independent variables, the dependent variable(s), and if

applicable, the moderating and intervening variables are elaborated. The elaboration of the variables in the theoretical framework addresses the issues of why or how we expect certain relationships to exist, and the nature and direction of the relationships among the variables of interest. At the end, the whole discussion can be portrayed in a schematic diagram.

Purpose of Formulating the Theoretical Framework

- It helps the researcher see clearly the variables of the study
- It can provide him with a general framework for data analysis
- It is essential in preparing a research proposal using descriptive and experimental methods.

Major Theoretical Frameworks

The following table briefly describes the key concepts of assumption of the four major theoretical frameworks of sociology

Major Theoretical Frameworks	
Structural Functionalism Major concepts. System, equilibrium, dysfunction, division of labor. Key assumptions. Society is a system of inter-dependent parts that is in equilibrium or balance. Over time, society has evolved from a simple to a complex type, which has highly specialized parts. The parts of society fulfill different needs or functions of the social system. A basic consensus on values or a value system holds society together. Exchange Theory (Also Rational Choice) Major concepts. Opportunities, rewards, approval, balance, credit Key assumptions. Human interactions are similar to economic transactions. People give and receive resources (symbolic, social approval, or material) and try to maximize their rewards while avoiding pain, expense, and embarrassment. Exchange relations tend to be balanced. If they are unbalanced, persons with credit can dominate others.	Symbolic Interactionism Major concepts. Self, reference group, role-playing, perception Key assumptions. People transmit and receive symbolic communication when they socially interact. People create perceptions of each other and social settings. People largely act on their perceptions. How people think about themselves and others is based on their interactions. Conflict Theory Major concepts. Power, exploitation, struggle, inequality, alienation Key assumptions. Society is made up of groups that have opposing interests. Coercion and attempts to gain power are ever-present aspects of human relations. Those in power attempt to hold onto their power by spreading myths or by using violence if necessary.

Basic Feature of Theoretical Framework

There are six basic features that should be incorporated in any theoretical framework. These features are:

1. Make an inventory of variables: For developing a framework it appears essential to identify the factors relevant to the problem under study. These factors are the empirical realities which can be named at some abstract level called concepts. The concepts taking more than one value are the variables. In other words the researcher makes an inventory of relevant variables. The variables considered relevant to the study should be clearly identified and labeled in the discussion.

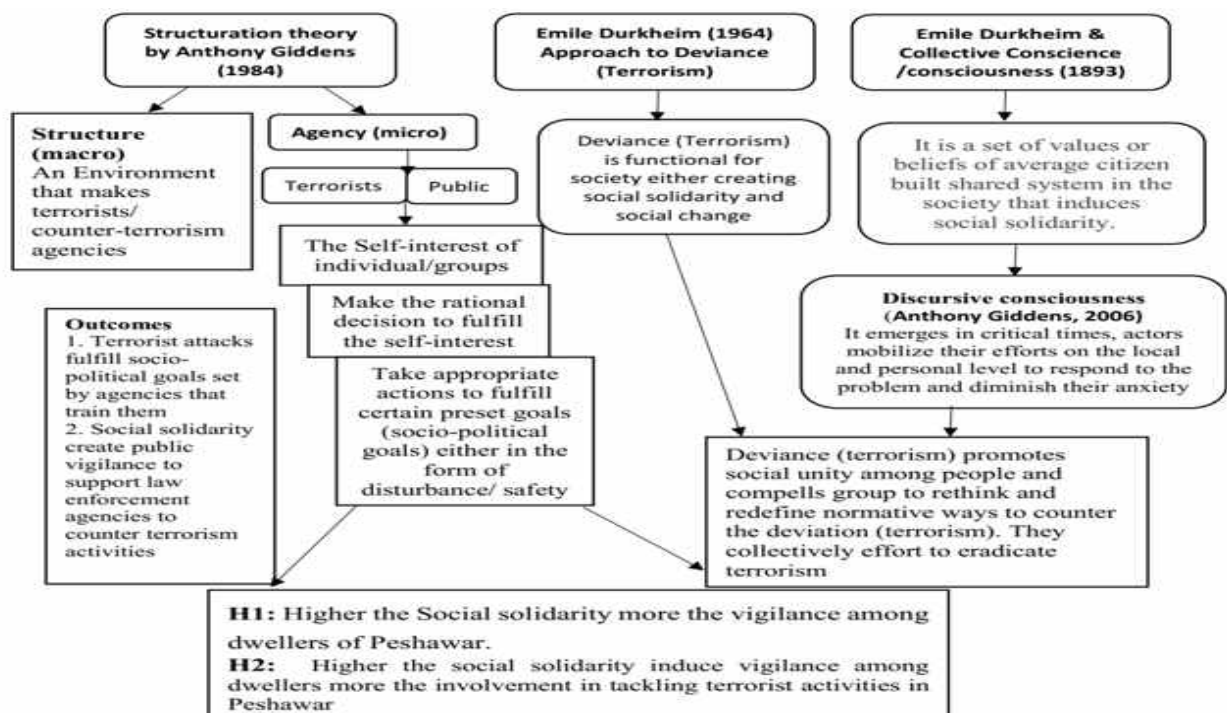
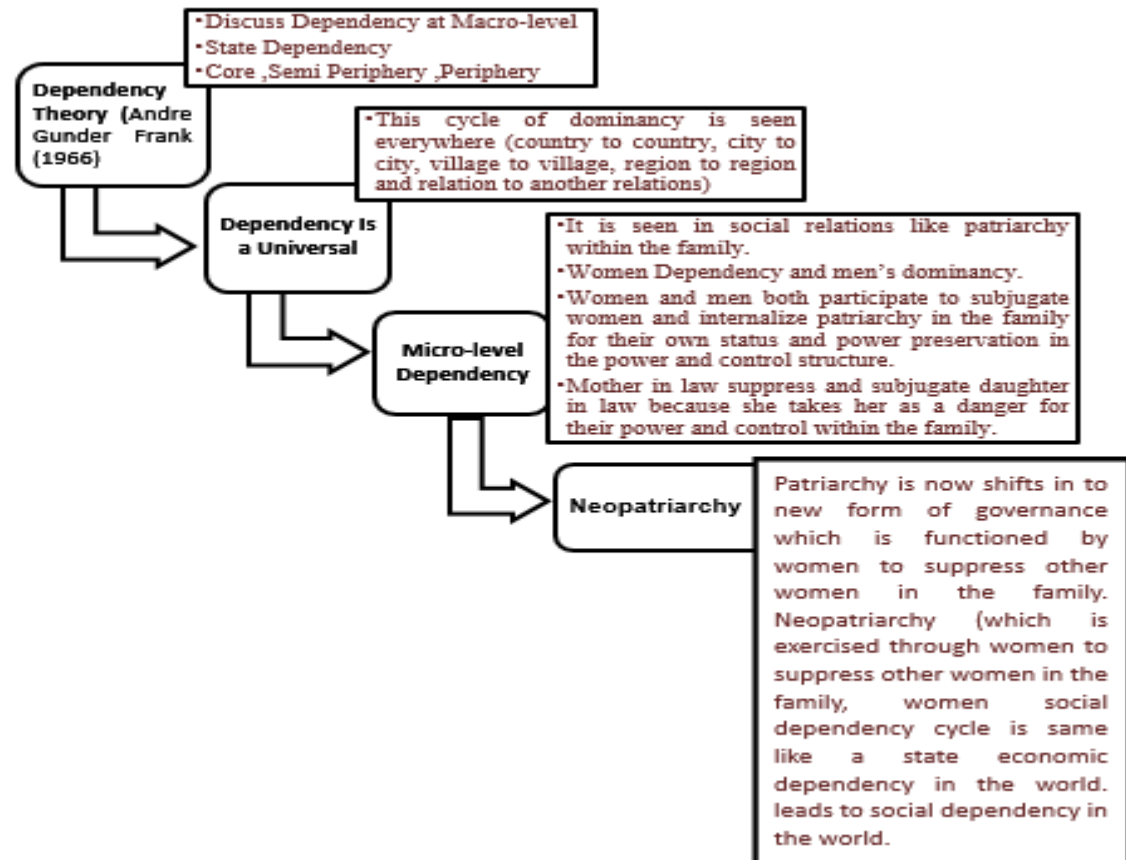
2. Specify the direction of relationship: If the nature and direction of relationship can be theorized on the basis of the findings of previous research, then there should be an indication in the discussion as to whether the relationship should be positive or negative. 3. Give a clear explanation of why we should expect the proposed relationships to exist. There should be clear explanation of why we would expect these relationships to exist. The arguments could be drawn from the previous research findings. The discussions should state how two or more variables are related to one another. This should be done for the important relationships that are theorized to exist among the variables. It is essential to theorize logical relationship between different variables.

4. Make an inventory of propositions: Stipulation of logical relationship between any two variables means the formulation of a proposition. If such relationships have been proposed between different variables, it will result in the formulation of a number of propositions. Let us call such a collection of propositions as an inventory of propositions. Each proposition is backed up by strong theoretical argumentation.

5. Arrange these propositions in a sequential order: One proposition generates the next proposition, which generates the next following proposition, which in turn generates the next following proposition, and so on. This is an axiomatic way of the derivation of propositions. Resultantly it will provide us a sequentially arranged set of propositions which are interlinked and interlocked with each other. Theory, if you remember, is an interrelated set of propositions. Therefore, the present interrelated set of propositions relevant to a particular problem is in fact a theoretical framework explaining the pathways of logical relationships between different variables.

6. Schematic diagram of the theoretical model be given: A schematic diagram of the theoretical framework should be given so that the reader can see and easily comprehend the theorized relationships. Example: Research Question: Why middle class families decline in their size?

Examples of Theoretical Framework



Importance of Theory

A theoretical framework consists of concepts, together with their definitions, and existing theory/theories that are used for your particular study. The theoretical framework must demonstrate an understanding of theories and concepts that are relevant to the topic of your research paper and that will relate it to the broader fields of knowledge in the class you are taking.

The theoretical framework is not something that is found readily available in the literature. You must review course readings and pertinent research literature for theories and analytic models that are relevant to the research problem you are investigating. The selection of a theory should depend on its appropriateness, ease of application, and explanatory power. The theoretical framework strengthens the study in the following ways. An explicit statement of theoretical assumptions permits the reader to evaluate them critically. To act in more informed and effective ways.

The Theoretical Framework Strengthens the Study in the Following Ways.

- An explicit statement of theoretical assumptions permits the reader to evaluate them critically.
- The theoretical framework connects the researcher to existing knowledge. Guided by a relevant theory, you are given a basis for your hypotheses and choice of research methods.
- Articulating the theoretical assumptions of a research study forces you to address questions of why and how. It permits you to move from simply describing a phenomenon observed to generalizing about various aspects of that phenomenon.
- Having a theory helps you to identify the limits to those generalizations. A theoretical framework specifies which key variables influence a phenomenon of interest. It alerts you to examine how those key variables might differ and under what circumstances.
- By virtue of its application nature, good theory in the social sciences is of value precisely because it fulfills one primary purpose: to explain the meaning, nature, and challenges of a phenomenon, often experienced but unexplained in the world in which we live, so that we may use that knowledge and understanding.

Placement of a theory in quantitative research:

- In the introduction,
- In the review of literature.
- After hypothesis or research questions as a rationale.
- Separate section of the study (ideal so that researcher can clearly identify the theory vis-à-vis the study)

Placement	Advantages	Disadvantages
In the introduction	As an approach often found in journal articles, it will be familiar to readers. It conveys a deductive approach.	It is difficult for a reader to isolate and separate theory base from other components of the research process (e.g., with the methods).
In the literature review	Theories are found in the literature, and their inclusion in a literature review is a logical extension or part of the literature.	It is difficult for a reader to see the theory in isolation from topics being reviewed in the literature.
After hypotheses or research questions as a rationale	The theory discussion is a logical extension of hypotheses or research questions because it explains how and why variables are related.	A writer may include a theoretical rationale after hypotheses and questions and leave out an extended discussion about the origin and rationale for the use of the theory.
In a separate section	This approach clearly separates the theory from other components of the research process, and it enables a reader to better identify and to understand the theory base for the study.	The theory discussion stands in isolation from other components of the research process (e.g., the questions or the methods) and, as such, a reader may not easily connect it with other components of the research process.

Writing a Quantitative Theory Perspectives

Using these ideas, the following presents a model for writing a quantitative theoretical perspective section into a research plan. Assume that the task is to identify a theory that explains the relationship between independent and dependent variables.

1. Look in the discipline-based literature for a theory.

If the unit of analysis for variables is an individual, look in the psychology literature; to study groups or organizations, look in the sociological literature. If the project examines individuals and groups, consider the social psychology literature. Of course, theories from other disciplines may be useful, too (e.g., to study an economic issue, the theory may be found in economics).

2. Examine also prior studies that address the topic or a closely related topic.

What theories did the authors use? Limit the number of theories and try to identify one overarching theory that explains the central hypothesis or major research question.

3. Bridges the independent and dependent variables: Why would the independent variable(s) influence the dependent variables?

4. Script out the theory section. Follow these lead sentences:

“The theory that I will use is ____ (name of theory). It was developed by ____ (identify the origin, source or developer of the theory), and it was used to study ____ (identify the topics where one finds the theory being applied). This theory indicates that ____ (id the propositions of hypotheses in the theory). As applied to my study, this theory holds that I would expect my independent variable/s ____ (state independent variables) to influence or explain the dependent variable/s (state dependent variables) because ____ (provide a rationale based on the logic of the theory).

References

- Creswell, J. W. & Creswell, J. D. (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.
- Neumann, L. (2014). *Social Research Methods: Qualitative and Quantitative Approaches*. Seven Edition. Pearson.

Lesson 08**CONCEPTUALIZATION AND OPERATIONALIZATION****Topic 008: Conceptualization and Operationalization****Concepts**

Concepts are constructs; they represent the agreed-on meanings we assign to terms. Our concepts don't exist in the real world, so they cannot be measured directly, but we can measure the things our concepts directly, but we can measure the things our concepts summarize.

Example

The concept "feminism" does not exist in the real world. But one can measure whether somebody talks a real world. But one can measure whether somebody talks a lot about men and women being lot about men and women being equal, goes to the rallies equal, goes to the rallies about the equality of men and women, and/or gives about the equality of men and women, and/or gives speeches about the equality of men and women. From the speeches about the equality of men and women. From the measurement of these behavior, one can construct a measurement of these behavior, one can construct a measurement for "feminism."

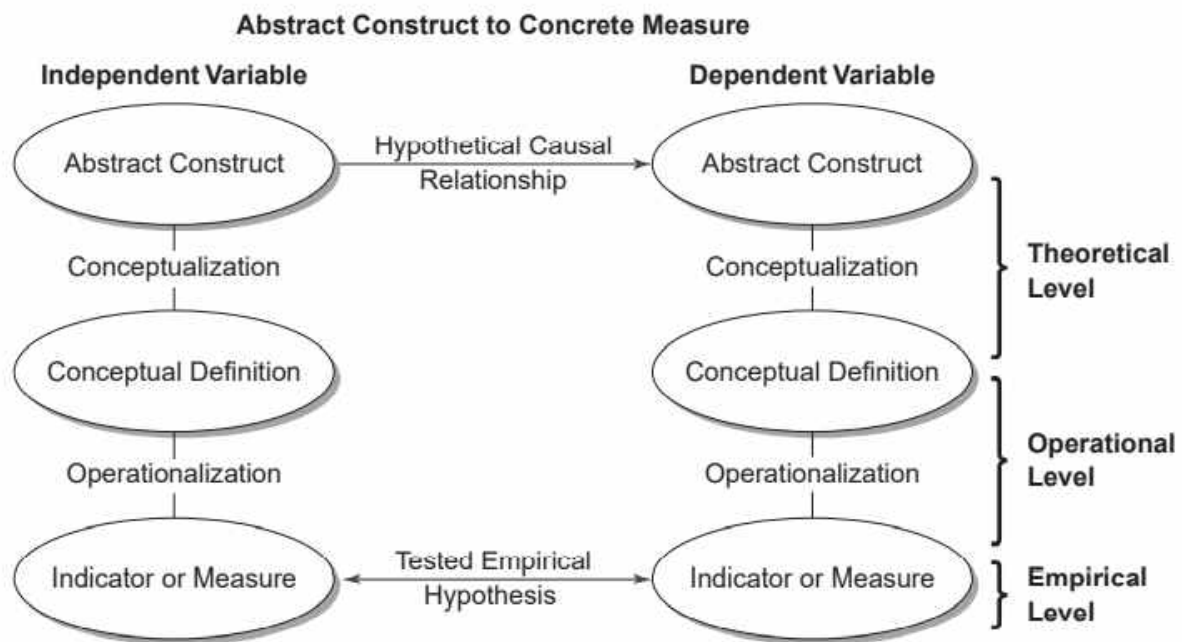


FIGURE 1 Conceptualization and Operationalization

Conceptualization

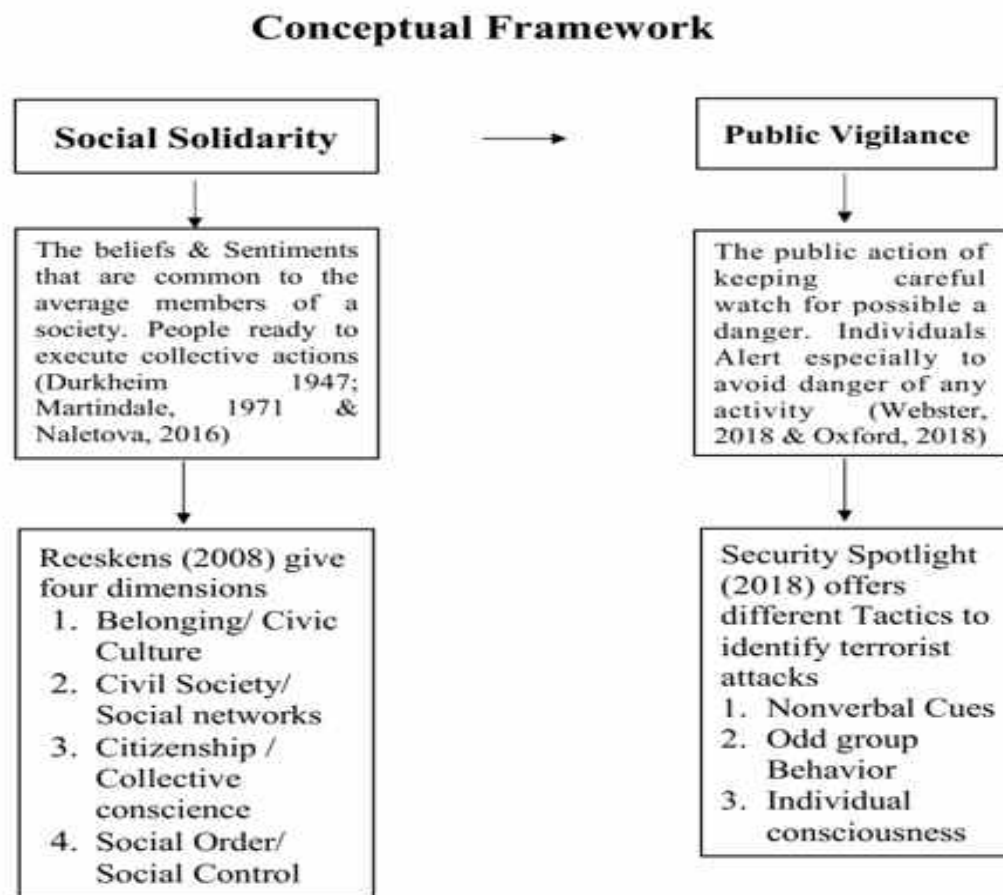
Conceptualization is the process of specifying what we mean when we use particular terms. It is the reverse process of when we use particular terms. It is the reverse process of conception.

Example

When we see the concept "feminism", we make a list of of phenomena representing the concept. The list could include the three items listed on the previous slide. Items listed on the previous slide. This list can be somewhat different individual by individual. But people t people

usually agree on the basic things. Usually agree on the basic things. In research, conceptualization produces an agreed upon meaning for a concept for the purposes of research. Different researchers may conceptualize a concept slightly differently. Conceptualization describes the indicators we'll use to measure the concept and the different aspects of the concept.

Example of Conceptual Framework



What are Nominal and Operational Definitions?

Nominal Definition - assigned to a term without a claim assigned to a term without a claim that the definition represents a "real" entity.

Operational Definitions - Specifies how a concept will be measured.

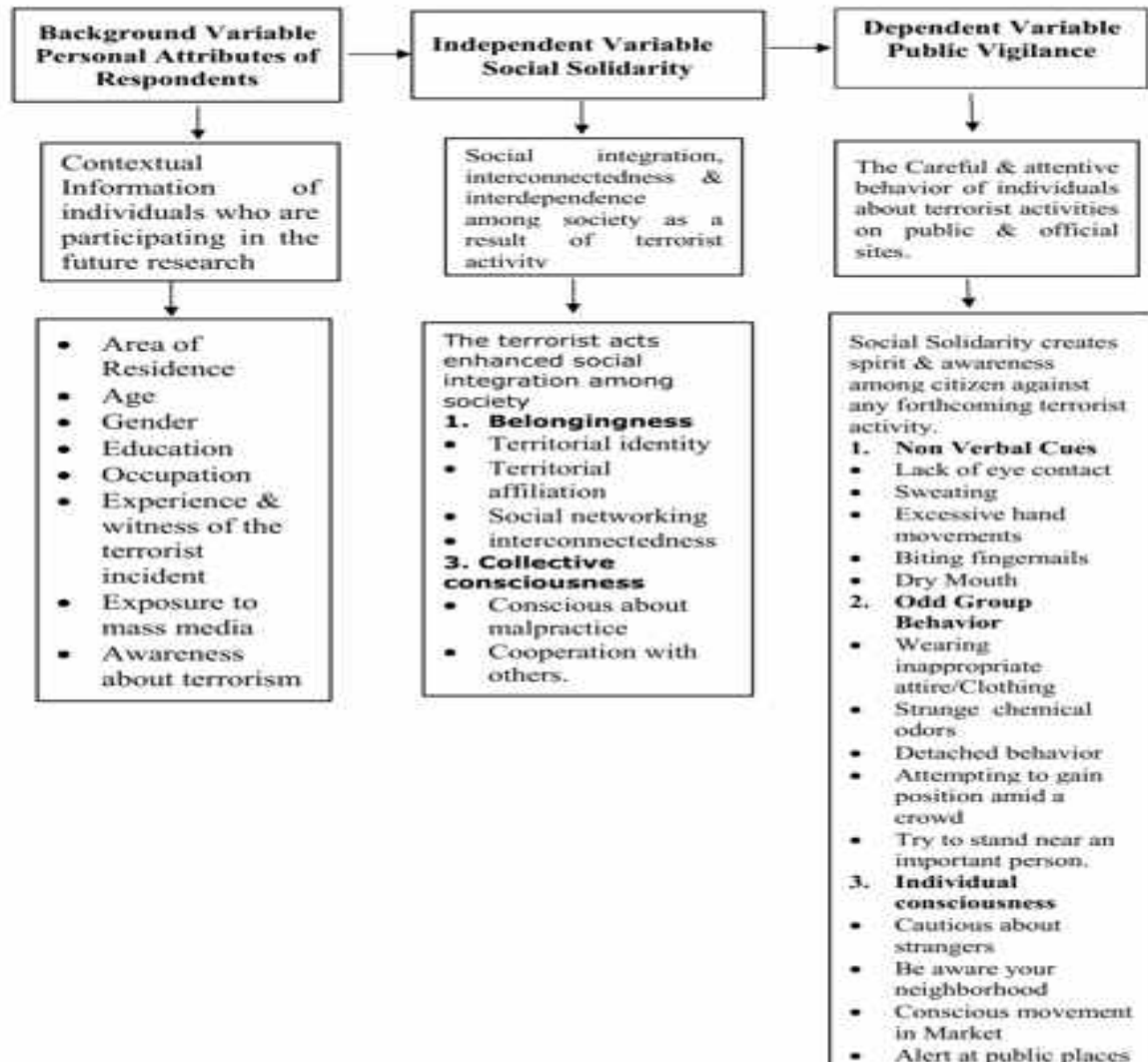
What are dimensions and indicators?

Complicated concepts have dimensions and indicators. Dimensions are specific aspects of a concept. Indicators are groups by dimensions. The end product of conceptualization is the specification of a set of indicators of what we have in mind, indicating the presence or absence of the mind, indicating the presence or absence of the concept. The Interchangeability of Indicators. If several different indicators all represent the same concept, then all of them will behave the same way that the concept would behave.

Operationalization

Operationalization is the development of specific research procedures that will result in empirical observations representing the concepts.

Example of Operational Framework



Operationalization issues – Range of variation, variation between extremes, and dimensions

Range of variation

The limits of your attributes Range of variation: the limits of your attributes

Examples: age, income.

Variations between the Extremes

How many attributes to have between the extremes.

Example: age, income, marital status.

More-precise measurement is usually better than less- precise measurement.

Rule of thumb: Whenever you are not sure how much detail you want to get in a measurement, get too much rather than too little.

Dimensions: most variables only measure on dimension of a concept.

References

Neumann, L. (2014). *Social Research Methods: Qualitative and Quantitative Approaches*. Seven Edition. Pearson.

Lesson 09**RESEARCH QUESTIONS AND HYPOTHESIS****Topic 009: Research Questions & Hypothesis****Introduction**

In quantitative studies, investigators use quantitative research questions and hypotheses, and sometimes objectives, to shape and specifically focus the purpose of the study.

Quantitative research questions

Quantitative research questions inquire about the relationships among variables that the investigator seeks to know. They are frequently used in social science research and especially in survey studies.

Example

Here is an example of a script for a quantitative research question describing outcomes of score for a variable:

What is the frequency and variation of scores on _____ (name the variable) for _____ (participants) in the study?

Here is an example of a script for a quantitative research question focused on examining the relationship among variables:

Does _____ (name the theory) explain the relationship between _____ (independent variable) and _____ (dependent variable), controlling for the effects of _____ (control variable)?

Quantitative hypotheses

Quantitative hypotheses are predictions the researcher makes about the expected outcomes of relationships among variables. They are numeric estimates of population values based on data collected from samples. Testing of hypotheses employs statistical procedures in which the investigator draws inferences about the population from a study sample. Hypotheses are used often in experiments in which investigators compare groups. Advisers sometimes recommend their use in a formal research project, such as a dissertation or thesis, as a means of stating the direction a study will take.

Example

Alternatively, a script for a quantitative null hypothesis might be as follows:

There is no significant difference between _____ (the control and experimental groups on the independent variable) on _____ (dependent variable).

Research Objectives

Research Objectives indicate the goals or objectives for a study. They often appear in proposals for funding, but tend to be used with less frequency in social and health science research. Because of this, the focus here will be on research questions and hypotheses.

Guidelines for writing good quantitative research questions and hypotheses

Guidelines for writing good quantitative research questions and hypotheses include the following.

- The use of variables in research questions or hypotheses is typically limited to three basic approaches. The researcher may compare groups on an independent variable to see its

impact on a dependent variable (this would be an experiment or group comparisons). Alternatively, the investigator may relate one or more independent variables to one or more dependent variables (this would be a survey that correlates variables). Third, the researcher may describe responses to the independent, mediating, or dependent variables (this would be a descriptive study). Most quantitative research falls into one or more of these three categories.

- The most rigorous form of quantitative research follows from a test of a theory and the specification of research questions or hypotheses that logically follow from the relationship among variables in the theory.
- The independent and dependent variables must be measured separately and not measured on the same concept. This procedure reinforces the cause-and-effect logic of quantitative research.
- To eliminate redundancy, write only research questions or hypotheses—not both—unless the hypotheses build on the research questions. Choose the form based on tradition, recommendations from an adviser or faculty committee, or whether past research indicates a prediction about outcomes.
- If hypotheses are used, there are two forms: (a) null and (b) alternative. A null hypothesis represents the traditional approach: It makes a prediction that in the general population, no relationship or no significant difference exists between groups on a variable. The wording is, “There is no difference (or relationship)” between the groups.

Types of Hypotheses

1. Descriptive Hypothesis

Descriptive hypothesis contains only one variable thereby it is also called as univariate hypothesis. Descriptive hypotheses typically state the existence, size, form, or distribution of some variable. The first hypothesis contains only one variable. It only shows the distribution of the level of commitment among the officers of the organization which is higher than average. Such a hypothesis is an example of a Descriptive Hypothesis. Researchers usually use research questions rather than descriptive hypothesis. For example a question can be: What is the level of commitment of the officers in your organization?

2. Relational Hypothesis

These are the propositions that describe a relationship between two variables. The relationship could be non-directional or directional, positive or negative, causal or simply co-relational. While stating the relationship between the two variables, if the terms of positive, negative, more than, or less than are used then such hypotheses are directional because the direction of the relationship between the variables (positive/negative) has been indicated. These hypotheses are relational as well as directional.

Directional Hypothesis

The directional hypothesis is the one in which the direction of the relationship has been specified.

Non-directional Hypothesis

Non-directional hypothesis is the one in which the direction of the association has not been specified. The relationship may be very strong but whether it is positive or negative has not been postulated.

Co-relational Hypotheses:

Co-relational hypotheses state merely that the variables occur together in some specified manner without implying that one causes the other. Such weak claims are often made when we believe that there are more basic causal forces that affect both variables. **For example:** Level of job commitment of the officers is positively associated with their level of efficiency. Here we do not make any claim that one variable causes the other to change. That will be possible only if we have control on all other factors that could influence our dependent variable.

Explanatory (causal) Hypotheses

Explanatory (causal) hypotheses imply the existence of, or a change in, one variable causes or leads to a change in the other variable. This brings in the notions of independent and the dependent variables. Cause means to “help make happen.” So the independent variable may not be the sole reason for the existence of, or change in the dependent variable. The researcher may have to identify the other possible causes, and control their effect in case the causal effect of independent variable has to be determined on the dependent variable. This may be possible in an experimental design of research.

3. Null Hypothesis

It is used for testing the hypothesis formulated by the researcher. Researchers treat evidence that supports a hypothesis differently from the evidence that opposes it. They give negative evidence more importance than to the positive one. It is because the negative evidence tarnishes the hypothesis. It shows that the predictions made by the hypothesis are wrong. The null hypothesis simply states that there is no relationship between the variables or the relationship between the variables is “zero.” That is how symbolically null hypothesis is denoted as “H₀”.

For example:

H₀ = There is no relationship between the level of job commitment and the level of efficiency.
 Or H₀ = The relationship between level of job commitment and the level of efficiency is zero.
 Or The two variables are independent of each other. It does not take into consideration the direction of association (i.e. H₀ is non directional), which may be a second step in testing the hypothesis. First we look whether or not there is an association then we go for the direction of association and the strength of association. Experts recommend that we test our hypothesis indirectly by testing the null hypothesis. In case we have any credibility in our Research Methods hypothesis then the research data should reject the null hypothesis. Rejection of the null hypothesis leads to the acceptance of the alternative hypothesis.

4. Alternative Hypothesis

The alternative (to the null) hypothesis simply states that there is a relationship between the variables under study. In our example it could be: there is a relationship between the level of job commitment and the level of efficiency. Not only there is an association between the two variables under study but also the relationship is perfect which is indicated by the number “1”. Thereby the alternative hypothesis is symbolically denoted as “H₁”. It can be written like this:

H₁: There is a relationship between the level of job commitment of the officers and their level of efficiency.

5. Research Hypothesis

Research hypothesis is the actual hypothesis formulated by the researcher which may also suggest the nature of relationship i.e. the direction of relationship. In our example it could be: Level of job commitment of the officers is positively associated with their level of efficiency.

The Role of the Hypothesis In research

A hypothesis serves several important functions:

1. It guides the direction of the study: Quite frequently one comes across a situation when the researcher tries to collect all possible information on which he could lay his hands on. Later on he may find that only part of it he could utilize. Hence there was an unnecessary use of resources on trivial concerns. In such a situation, hypothesis limits what shall be studied and what shall not be.
2. It identifies facts that are relevant and those that are not: Who shall be studied (married couples), in what context they shall be studied (their consumer decision making), and what shall be studied (their individual perceptions of their roles).
3. It suggests which form of research design is likely to be the most appropriate. It is depending upon the type of hypothesis a decision is made about the relative appropriateness of different research designs for the study under consideration. The design could be a survey design, experimental design, content analysis, case study, participation observation study, and/or Focus Group Discussions.
4. It provides a framework for organizing the conclusions of the findings.

Types of Research Question in Quantitative Research

There are two types of research question in quantitative research.

Descriptive Research Question (describing something)

Inferential Research Question (drawing inferences from a sample to a population)

These questions include both independent and dependent variables. Descriptive questions for each independent and dependent variable and important intervening or moderating variables are specified in the following table. Inferential questions that relate variables or compare groups follow these descriptive questions.

To illustrate this approach, a researcher wants to examine the relationship of critical thinking skills (an independent variable measured on an instrument) to student achievement (a dependent variable measured by grades) in science classes for eighth-grade students in a large metropolitan school district. The researcher moderates the assessment of critical thinking using prior grades as indicators in science classes and controls for parents' educational attainment. Following the proposed model, the research questions might be written as follows:

Descriptive Questions

1. How do the students rate on critical thinking skills? (A descriptive question focused on the independent variable)
2. What are the student's achievement levels (or grades) in science classes? (A descriptive question focused on the dependent variable)
3. What are the student's prior grades in science classes and their critical thinking skills? (A descriptive question focused on the moderating variable of prior grades)
4. What is the educational attainment of the parents of the eighth graders? (A descriptive question focused on a control variable, educational attainment of parents)

Inferential Questions

1. How does critical thinking ability relate to student achievement? (An inferential question relating the independent and the dependent variables)
2. How does critical thinking ability and prior grades influence student achievement? (An inferential question relating critical thinking times grades and student achievement)
3. How does critical thinking ability (or critical thinking ability times grades) relate to student achievement, controlling for the effects of the educational attainment of the eighth-graders' parents? (An inferential question relating the independent and the dependent variables, controlling for the effects of the controlled variable)

Examples of Bad and Good Research Questions

BAD RESEARCH QUESTIONS

Not Empirically Testable, Nonscientific Questions

- Should abortion be legal?
- Is it right to have capital punishment?

General Topics, Not Research Questions

- Treatment of alcohol and drug abuse
- Sexuality and aging

Set of Variables, Not Questions

- Capital punishment and racial discrimination
- Urban decay and gangs

Too Vague, Ambiguous

- Do police affect delinquency?
- What can be done to prevent child abuse?

Need to Be Still More Specific

- Has the incidence of child abuse risen?
- How does poverty affect children?
- What problems do children who grow up in poverty experience that others do not?

GOOD RESEARCH QUESTIONS

Exploratory Questions

- Has the incidence of new forms of child abuse appeared in Wisconsin in the past 10 years?

Descriptive Questions

- Is child abuse, violent or sexual, more common in families that have experienced a divorce than in intact, never-divorced families?
- Are the children raised in impoverished households more likely to have medical, learning, and social-emotional adjustment difficulties than children who are not living in poverty?

Explanatory Questions

- Does the emotional instability created by experiencing a divorce increase the chances that divorced parents will physically abuse their children?
- Is a lack of sufficient funds for preventive treatment a major cause of more serious medical problems among children raised in families in poverty?

References

- Creswell, J. W. & Creswell, J. D. (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.
- Neumann, L. (2014). *Social Research Methods: Qualitative and Quantitative Approaches*. Seven Edition. Pearson.

Lesson 10QUANTITATIVE RESEARCH DESIGNSTopic 010: Quantitative Research Design**Introduction**

It is a thorough outline of how a study is going to take place. It will generally consist of how data is to be collected, what tools will be used, how the tools will be used and the intended means for analyzing collected data.

Definition

It is the determination and statement of the general research approach or approach followed for the specific task. It is the heart of planning. If the design sticks to the research objective, it will guarantee that the client's needs will be served. – **David J Luck and Ronald S Rubin**

According to Green and Tull, "It is the specification of techniques and processes for obtaining the information required. It is the over-all operational pattern or framework of the project which states what data is to be gathered from which source by what processes."

Characteristics of Research Designs

There are different characteristics of research design.

Neutrality: When you set up your study, you may have to make assumptions about the data you expect to collect. The results projected in the research should be free from bias and neutral. Understand opinions about the final evaluated scores and conclusions from multiple individuals and consider those who agree with the derived results.

Reliability: With regularly conducted research, the researcher involved expects similar results every time. Your design should indicate how to form research questions to ensure the standard of results. You'll only be able to reach the expected results if your design is reliable.

Validity: There are multiple measuring tools available. However, the only correct measuring tools are those which help a researcher in gauging results according to the objective of the research. The questionnaire developed from this design will then be valid.

Generalization: The outcome of your design should apply to a population and not just a restricted sample. A generalized design implies that your survey can be conducted on any part of a population with similar accuracy.

**Components of Research Designs**

The five basic components of research design components apply to all types of qualitative, quantitative research, whether in the physical or social sciences.

1. **Research study's questions:** This first component suggests the type of the question-in terms of "who," "what," "where," "how," and "why"-provides an crucial clue concerning the most relevant research method to be used. Use three stages: In the first, make use of the literature to narrow your interest to a key topic or two. In the 2nd, take a look at closely-even dissect-a few key studies on your topic of interest. Identify the questions in those few studies and whether they conclude with new questions for future research. In the last phase, examine another group of scientific studies on the same topic. They might provide support for your potential questions or even suggest means of sharpening them.
2. **Study propositions:** Each proposition directs focus on something which needs to be examined within the scope of study. Only if you are forced to state some propositions will you move in the right direction. For example, you may think that businesses collaborate as they gain mutual benefits. This proposition, apart from highlighting a crucial theoretical issue (that other incentives for collaboration don't exist or are unimportant), also starts to tell you where you can search for related proof (to define and determine the extent of certain advantages to each business).

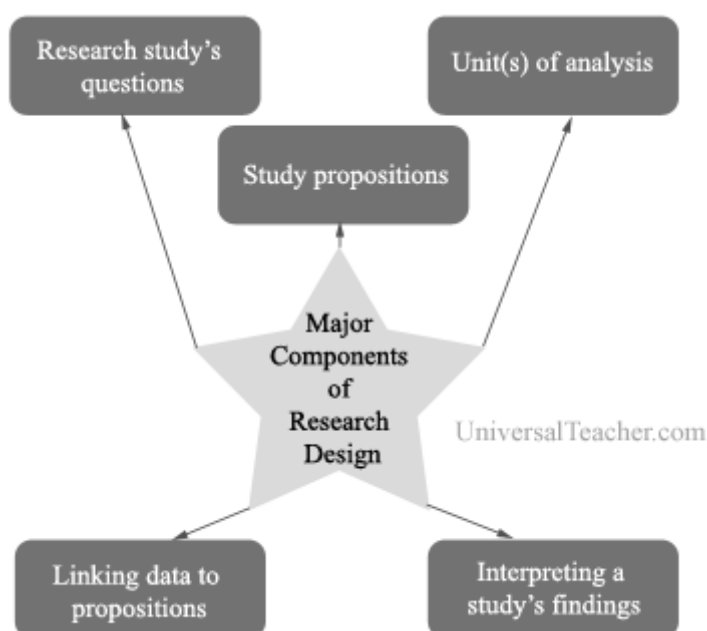


Figure: Key Components

3. **Unit of analysis:** It is associated with the fundamental problem of defining what the "case" is-a problem which has affected many researchers at the beginning of case studies. Take example of clinical patients. In this situation, an individual is being studied, and the individual is the key unit of analysis. Information regarding the appropriate individual will be collected, and several such individuals could be part of a multiple-case study. You would need study questions and propositions to help find out the appropriate information to be collected relating to this individual or individuals. Without such questions and propositions, you could be lured to cover "everything" with regards to the individual(s), which is not possible.
4. **Linking data to propositions:** Methods of linking data to propositions are pattern matching, explanation building, time-series analysis, logic models, and cross-case synthesis. The actual analyses will demand that you merge or compute your study data as a direct reflection of your initial study propositions.

5. **Interpreting a study's findings:** A statistical analysis determines if the results of the study support the hypothesis. A number of statistical tests, for example T-tests (that determine if two groups are statistically distinct from one another), Chi-square tests (where data are compared to an anticipated outcome) and one-way analysis of variance (provides for the comparison of multiple groups), are carried out according to the type of data, number and types of variables and data categories. Statistical analysis offer some explicit criteria for interpretations. For example, by convention, social science views a p level of less than .05 to indicate that observed differences were "statistically important." On the other hand, much case study analysis is not going to depend on the use of statistics and so focuses on other methods of thinking about such criteria.

Types of Research Designs

There are four main types of Quantitative research: Descriptive, Correlational, Causal-Comparative/Quasi-Experimental, and Experimental Research.

Types of Quantitative Design			
			
Descriptive research seeks to describe the current status of an identified variable. These research projects are designed to provide systematic information about a phenomenon. The researcher does not usually begin with an hypothesis, but is likely to develop one after collecting data. The analysis and synthesis of the data provide the test of the hypothesis. Systematic collection of information requires careful selection of the units studied and careful measurement of	Correlational research attempts to determine the extent of a relationship between two or more variables using statistical data. In this type of design, relationships between and among a number of facts are sought and interpreted. This type of research will recognize trends and patterns in data, but it does not go so far in its analysis to prove causes for these observed patterns. Cause and effect is not the basis of this type of observational research. The data, relationships, and distributions of variables	Causal-comparative/quasi-experimental research attempts to establish cause-effect relationships among the variables. These types of design are very similar to true experiments, but with some key differences. An independent variable is identified but not manipulated by the experimenter, and effects of the independent variable on the dependent variable are measured. The researcher does not randomly assign groups and must use ones that are naturally formed or pre-existing groups. Identified control groups exposed to the treatment	Experimental research , often called true experimentation, uses the scientific method to establish the cause-effect relationship among a group of variables that make up a study. The true experiment is often thought of as a laboratory study, but this is not always the case; a laboratory setting has nothing to do with it. A true experiment is any study where an effort is made to identify and impose control over all other variables except one. An independent variable is manipulated to determine the effects on the dependent variables. Subjects are randomly assigned to

each variable. Examples of Descriptive Research: - A description of how second-grade students spend their time during summer vacation - A description of the tobacco use habits of teenagers - A description of how parents feel about the twelve-month school year - A description of the attitudes of scientists regarding global warming - A description of the kinds of physical activities that typically occur in nursing homes, and how frequently each occurs - A description of the extent to which elementary teachers use math manipulatives	are studied only. Variables are not manipulated; they are only identified and are studied as they occur in a natural setting. <i>*Sometimes correlational research is considered a type of descriptive research, and not as its own type of research, as no variables are manipulated in the study.</i> Examples of Correlational Research: - The relationship between intelligence and self-esteem - The relationship between diet and anxiety - The relationship between an aptitude test and success in an algebra course - The relationship between ACT scores and the freshman grades - The relationships between the types of activities used in math classrooms and student achievement - The covariance of smoking and lung disease	variable are studied and compared to groups who are not. When analyses and conclusions are made, determining causes must be done carefully, as other variables, both known and unknown, could still affect the outcome. A causal-comparative designed study, described in a <i>New York Times</i> article, "The Case for \$320,00 Kindergarten Teachers," illustrates how causation must be thoroughly assessed before firm relationships amongst variables can be made. Examples of Correlational Research: - The effect of preschool attendance on social maturity at the end of the first grade - The effect of taking multivitamins on a students' school absenteeism - The effect of gender on algebra achievement - The effect of part-time employment on the achievement of high school students - The effect of magnet school participation on student attitude - The effect of age on lung capacity	experimental treatments rather than identified in naturally occurring groups Examples of Experimental Research: - The effect of a new treatment plan on breast cancer - The effect of positive reinforcement on attitude toward school - The effect of teaching with a cooperative group strategy or a traditional lecture approach on students' achievement - The effect of a systematic preparation and support system on children who were scheduled for surgery on the amount of psychological upset and cooperation - A comparison of the effect of personalized instruction vs. traditional instruction on computational skill
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A researcher must have knowledge of various types of research designs to choose which type of research design should be applied for the research. There are different types of research designs which are explained below.

1. Descriptive Design

Descriptive design includes phenomena being researched and characteristics of population. To describe internal validity does not require characteristics of population. It used for statistics of data, average and frequencies.

Advantage

- Amount of data gathered by this research and which can be used for future references.
- It gives overviews of study which is helpful to determines variables used for study.
- Limitation of study can use for development or as a useful tools.

Disadvantage

- To disapprove hypothesis, outcome of descriptive design cannot be used.
- Study depends on measurement and instrumentation for observation.
- Using observational method outcome can be collected.

2. Experimental Design

The casual relationship where particular cause leads to same effect, cause will proceed to effect so degree of associate is major. The procedure is main which controls all factors of experiment. Experimental design uses more measurements and more groups for longer periods of time.

Advantage

- Placebo effects can be determined from treatment effects.
- From single study high level of evidence can be collected.
- It determines cause of something to take place.

Disadvantage

- Because of technical or ethical reasons few types of proceeds cannot be performed.
- It might not fit into real time.
- If procedure uses special equipment and facilities, experiments can be costly.

3. Correlational Design

Correlational research is used to establish a relationship between two close entities and to determine how one impacts the other. For this, a researcher needs at least two separate groups. This type of research will recognize trends and patterns in data, but it does not go so far in its analysis to observe the different patterns. Correlational research sometimes considered a type of descriptive research as no variables are manipulated in the study. Cause and effect are not the basis of this type of observational research. **Examples** of Correlational research include the relationships between the types of activities of mathematics classrooms and the achievement of students, the relationship between diet and anxiety.

4. Casual-Comparative Research

Casual-Comparative research is employed to conclude the cause-effect equation between two or more variables, where one variable depends on the opposite experimental variable. An independent variable is not manipulated by the experimenter, and the effects of the independent variable is on the dependent variable are measured. This sort of analysis is not restricted to the applied mathematics of two variables but extends to analyzing different variables and groups. Casual-Comparative research is a method that works on the process of comparison. Once

analysis and conclusions are made, deciding about the causes should be done fastidiously, as other different variables, each far-famed and unknown, might still have an effect on the result. Examples of this type of research include the effect of preschool attendance on social maturity at the end of the first grade, the impact of drugs on a teenager

Longitudinal Design

This research design makes multiple observation, repetitive study and experiments. This involved same group of people for study over period of time. The variable are identify and cause are found which made variable have caused change in their behavior. This also called panel research design.

Advantage

- Data can be collected from particular phenomenon.
- Various variable established causal relationship.
- Pattern of change can be tracked.

Disadvantage

- Method is changed over time, but researcher assumes that present trend may remain same for future also.

5. Cross-Sectional Design

The research design calculated among study participants at some time. Research variable data analyze from sample population which is collected from given point of time. It has selection based on differences rather than selection, dependence based on existing variations; no time dimension so distinguishing features can be analyzed.

Advantage

- Study used for large number of subjects.
- Grouping not selected, randomly based on population grouping is done.
- At a point in time provides characteristics of result.
- Results performed on population are more reliable.
- Use large number of subject involves.

Disadvantage

- Very difficult to find same interest phenomena or subjects.
- Outcome does not provide any historical occurrence because of time-bound procedures.
- Different outcome from different time-frame.
- Cause and effect relationship cannot be determined from this research.

6. Action Research Design

In this exploratory and understanding of problem is developed to follow characteristic based path to made strategies of intervention. Various forms are collected to follow new intervention strategies until problem strategies established. This path is cyclic; provide initializing, hypothesizing and specifying problem to make interventions and assessments.

Advantage

- Because of cooperative and adaptive nature it can be used in community or world situation.

- It mainly focuses on solution driven and practical besides than theories.
- It increases change of learning from experiences also viewed as cyclic.
- Outcome is related to practice.
- Researcher has nothing to hide and controlled information.

Disadvantage

- It is responsibility of researcher to enhance change so difficult to perform conventional studies.
- Test result may be bias one due to over- involvement of researcher.
- Documentation is really difficult because of no standard format.
- It is cyclic in nature so action research is difficult to conduct.

7. Causal Design

They relates with understanding of phenomenon with statements "If A, then B". According to assumptions and norms one can made certain changes in this kind of research. The explanation of test by hypothesis seeks by majority of scientists like dependent variable, independent variable, variation in one phenomenon, variation in other phenomenon.

Advantage

- Chances of replicate are more.
- Study has systematic subject selection and has internal validation.
- It helps the word better understanding by providing link between variables and eliminates possibilities.

Disadvantage

- Two different events seem to be related and cannot be casual.
- Causality only inferred but because variable superfluous and perplexing variable exist so difficult to determine conclusion about relationship.
- It is not easy to predict which variable is cause and which is effect.

References

Pawar, N. (2020, December).Type of Research and Type Research Design. Research Methodology (An Overview) (pp.46-57). Publisher: KD Publications.

Lesson 11**DESCRIPTIVE RESEARCH DESIGN****Topic 011: Descriptive Research Designs****Descriptive research**

Descriptive research aims to accurately and systematically describe a population, situation or phenomenon. It can answer *what*, *where*, *when* and *how* questions, but not *why* questions. A descriptive research design can use a wide variety of research methods to investigate one or more variables. Unlike in experimental research, the researcher does not control or manipulate any of the variables, but only observes and measures them.

Characteristics of Descriptive Research

Some distinctive characteristics of descriptive research are:

1. **Quantitative research:** Descriptive research is a quantitative research method that attempts to collect quantifiable information for statistical analysis of the population sample. It is a popular market research tool that allows us to collect and describe the demographic segment's nature.
2. **Uncontrolled variables:** In descriptive research, none of the variables are influenced in any way. This uses observational methods to conduct the research. Hence, the nature of the variables or their behavior is not in the hands of the researcher.
3. **Cross-sectional studies:** Descriptive research is generally a cross-sectional study where different sections belonging to the same group are studied.
4. **The basis for further research:** Researchers further research the data collected and analyzed from descriptive research using different research techniques. The data can also help point towards the types of research methods used for the subsequent research.

When to use a descriptive research design

Descriptive research is an appropriate choice when the research aim is to identify characteristics, frequencies, trends, and categories. It is useful when not much is known yet about the topic or problem. Before you can research why something happens, you need to understand how, when and where it happens. Descriptive research can be used to investigate the background of a research problem and get the required information needed to carry out further research. It is used in multiple ways by different organizations, and especially when getting the required information about their target audience.

- **Define subject characteristics:**

It is used to determine the characteristics of the subjects, including their traits, behaviour, opinion, etc. This information may be gathered with the use of surveys, which are shared with the respondents who in this case, are the research subjects.

For example, a survey evaluating the number of hours millennials in a community spends on the internet weekly, will help a service provider make informed business decisions regarding the market potential of the community.

- **Measure Data Trends**

It helps to measure the changes in data over some time through statistical methods. Consider the case of individuals who want to invest in stock markets, so they evaluate the changes in prices of the available stocks to make a decision investment decision.

Brokerage companies are however the ones who carry out the descriptive research process, while individuals can view the data trends and make decisions.

- **Comparison**

Descriptive research is also used to compare how different demographics respond to certain variables. For example, an organization may study how people with different income levels react to the launch of a new Apple phone.

This kind of research may take a survey that will help determine which group of individuals are purchasing the new Apple phone. Do the low-income earners also purchase the phone, or only the high-income earners do?

Further research using another technique will explain why low-income earners are purchasing the phone even though they can barely afford it. This will help inform strategies that will lure other low-income earners and increase company sales.

- **Validate existing conditions**

When you are not sure about the validity of an existing condition, you can use descriptive research to ascertain the underlying patterns of the research object. This is because descriptive research methods make an in-depth analysis of each variable before making conclusions.

- **Conducted Overtime**

Descriptive research is conducted over some time to ascertain the changes observed at each point in time. The higher the number of times it is conducted, the more authentic the conclusion will be.

Descriptive research question examples

- How has the Amsterdam housing market changed over the past 20 years?
- Do customers of company X prefer product X or product Y?
- What are the main genetic, behavioural and morphological differences between European wildcats and domestic cats?
- What are the most popular online news sources among under-18s?
- How prevalent is disease A in population B?

Descriptive research methods

Descriptive research is usually defined as a type of quantitative research, though qualitative research can also be used for descriptive purposes. The research design should be carefully developed to ensure that the results are valid and reliable.

Surveys

Survey research allows you to gather large volumes of data that can be analyzed for frequencies, averages and patterns. Common uses of surveys include:

- Describing the demographics of a country or region
- Gauging public opinion on political and social topics
- Evaluating satisfaction with a company's products or an organization's services

Observations

Observations allow you to gather data on behaviours and phenomena without having to rely on the honesty and accuracy of respondents. This method is often used by psychological, social and market researchers to understand how people act in real-life situations.

Observation of physical entities and phenomena is also an important part of research in the natural sciences. Before you can develop testable hypotheses, models or theories, it's necessary to observe and systematically describe the subject under investigation.

Case studies

A case study can be used to describe the characteristics of a specific subject (such as a person, group, event or organization). Instead of gathering a large volume of data to identify patterns across time or location, case studies gather detailed data to identify the characteristics of a narrowly defined subject.

Rather than aiming to describe generalizable facts, case studies often focus on unusual or interesting cases that challenge assumptions, add complexity, or reveal something new about a research problem.

Applications of descriptive research with examples

A descriptive research method can be used in multiple ways and for various reasons. Before getting into any survey, though, the survey goals and survey design are crucial. Despite following these steps, there is no way to know if one will meet the research outcome. How to use descriptive research? To understand the end objective of research goals, below are some ways organizations currently use descriptive research today:

- **Define respondent characteristics:** The aim of using close-ended questions is to draw concrete conclusions about the respondents. This could be the need to derive patterns, traits, and behaviors of the respondents. It could also be to understand from a respondent, their attitude, or opinion about the phenomenon. For example, understanding from millennials the hours per week they spend on browsing the internet. All this information helps the organization researching to make informed business decisions.
- **Measure data trends:** Researchers measure data trends over time with a descriptive research design's statistical capabilities. Consider if an apparel company researches different demographics like age groups from 24-35 and 36-45 on a new range launch of autumn wear. If one of those groups doesn't take too well to the new launch, it provides insight into what clothes are like and what is not. The brand drops the clothes and apparel that customers don't like.
- **Conduct comparisons:** Organizations also use a descriptive research design to understand how different groups respond to a specific product or service. For example, an apparel brand creates a survey asking general questions that measure the brand's image. The same study also asks demographic questions like age, income, gender, geographical location, etc. This consumer research helps the organization understand what aspects of the brand appeal to the population and what aspects do not. It also helps make product or marketing fixes or even create a new product line to cater to high growth potential groups.
- **Validate existing conditions:** Researchers widely use descriptive research to help ascertain the research object's prevailing conditions and underlying patterns. Due to the non-invasive research method and the use of quantitative observation and some aspects of qualitative observation, researchers observe each variable and conduct an in-depth analysis.

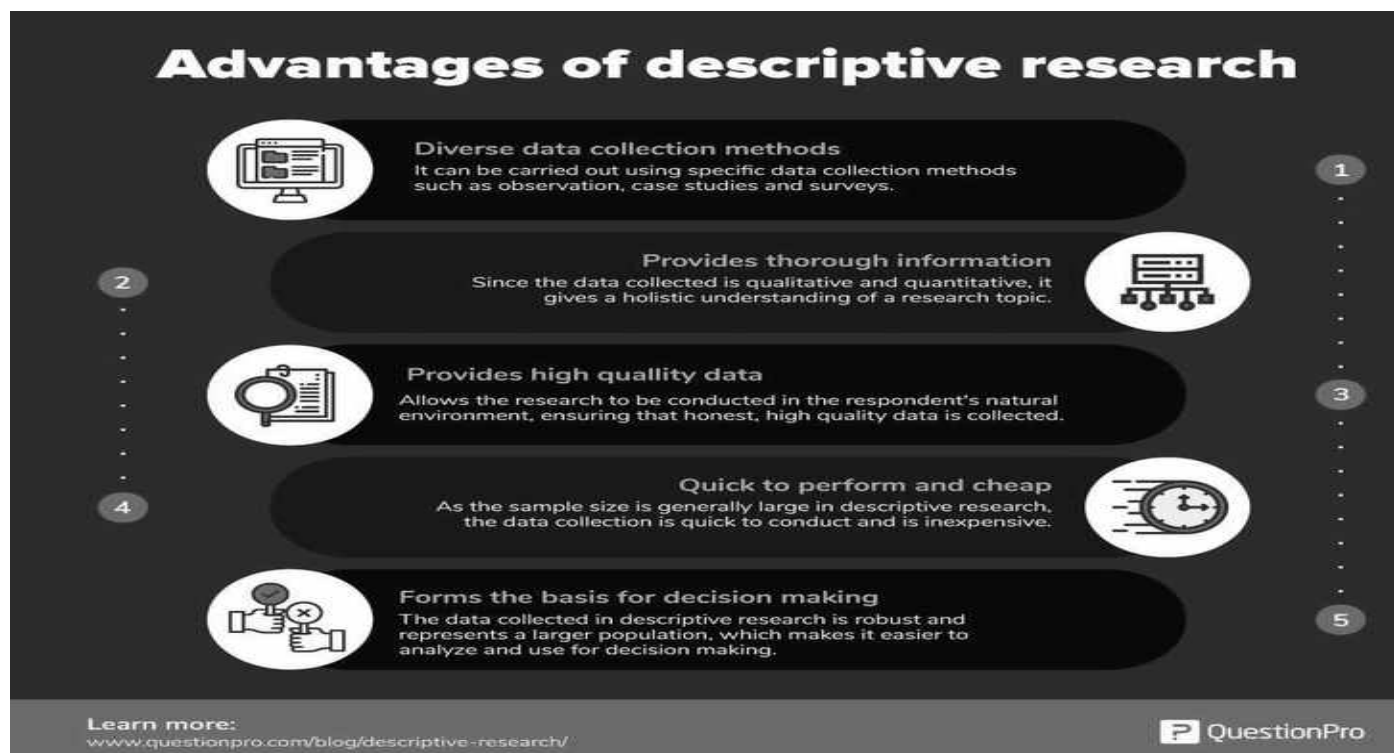
Researchers also use it to validate any existing conditions that may be prevalent in a population.

- **Conduct research at different times:** The analysis can be conducted at different periods to ascertain any similarities or differences. This also allows any number of variables to be evaluated. For verification, studies on prevailing conditions can also be repeated to draw trends.

Advantages of Descriptive Research

Some of the significant advantages of descriptive research are:

- **Data collection:** A researcher can conduct descriptive research using specific methods like observational method, case study method, and survey method. Between these three, all primary data collection methods are covered, which provides a lot of information. This can be used for future research or even developing a hypothesis of your research object.
- **Varied:** Since the data collected is qualitative and quantitative, it gives a holistic understanding of a research topic. The information is varied, diverse, and thorough.
- **Natural environment:** Descriptive research allows for the research to be conducted in the respondent's natural environment, which ensures that high-quality and honest data is collected.
- **Quick to perform and cheap:** As the sample size is generally large in descriptive research, the data collection is quick to conduct and is inexpensive.



Disadvantages of Descriptive Research

Respondents may either decide not to respond to questions or give incorrect responses if they feel the questions are too confidential. When researchers use observational methods, respondents may also decide to behave in a particular manner because they feel they are being watched.

- The researcher may decide to influence the result of the research due to personal opinion or bias towards a particular subject. For example, a stockbroker who also has a business of his own may try to lure investors into investing in his own company by manipulating results.
- A case-study or sample taken from a large population is not representative of the whole population.
- The scope of descriptive research is limited to the *what* of research, with no information on *why* thereby limiting the scope of the research.

Lesson 12**CORRELATIONAL RESEARCH DESIGN****Topic 012: Correlational Research Design****Correlational Research**

Correlational research is a type of research method that involves observing two variables in order to establish a statistically corresponding relationship between them. The aim of correlational research is to identify variables that have some sort of relationship to the extent that a change in one creates some change in the other. This type of research is descriptive, unlike experimental research that relies entirely on scientific methodology and hypothesis. For example, correlational research may reveal the statistical relationship between high-income earners and relocation; that is, the more people earn, the more likely they are to relocate or not.

Correlation Research Design

A correlational research design investigates relationships between variables without the researcher controlling or manipulating any of them. A correlation reflects the strength and/or direction of the relationship between two (or more) variables. The direction of a correlation can be either positive or negative.

Positive correlation	Both variables change in the same direction. As height increases, weight also increases.
Negative correlation	The variables change in opposite directions. As coffee consumption increases, tiredness decreases.
Zero correlation	There is no relationship. Coffee consumption is not correlated with height between the variables.

Types of Correlational Research?

Essentially, there are three types of correlational research which are positive correlational research, negative correlational research, and no correlational research. Each of these types is defined by peculiar characteristics.

- **Positive Correlational Research**

Positive correlational research is a research method involving 2 variables that are statistically corresponding where an increase or decrease in 1 variable creates a like change in the other. An example is when an increase in workers' remuneration results in an increase in the prices of goods and services and vice versa.

- **Negative Correlational Research**

Negative correlational research is a research method involving 2 variables that are statistically opposite where an increase in one of the variables creates an alternate effect or decrease in the other variable. An example of a negative correlation is if the rise in goods and services causes a decrease in demand and vice versa.

- **Zero Correlational Research**

Zero correlational research is a type of correlational research that involves 2 variables that are not necessarily statistically connected. In this case, a change in one of the variables may not trigger a corresponding or alternate change in the other variable.

Zero correlational research caters for variables with vague statistical relationships. For example, wealth and patience can be variables under zero correlational research because they are statistically independent.

Sporadic change patterns that occur in variables with zero correlational are usually by chance and not as a result of corresponding or alternate mutual inclusiveness.

Correlational research can also be classified based on data collection methods. Based on these, there are 3 types of correlational research: Naturalistic observation research, survey research and archival research.

Correlational research	
Purpose	Used to test strength of association between variables
Variables	Variables are only observed with no manipulation or intervention by researchers
Control	Limited control is used, so other variables may play a role in the relationship
Validity	High external validity: you can confidently generalize your conclusions to other populations or settings

When to use correlational research

Correlational research is ideal for gathering data quickly from natural settings. That helps you generalize your findings to real-life situations in an externally valid way.

There are a few situations where correlational research is an appropriate choice.

To investigate non-causal relationships

You want to find out if there is an association between two variables, but you don't expect to find a causal relationship between them.

Correlational research can provide insights into complex real-world relationships, helping researchers develop theories and make predictions.

Example: You want to know if there is any correlation between the number of children people have and which political party they vote for. You don't think having more children causes people to vote differently — it's more likely that both are influenced by other variables such as age, religion, ideology and socioeconomic status. But a strong correlation could be useful for making predictions about voting patterns.

To explore causal relationships between variables

You think there is a causal relationship between two variables, but it is impractical, unethical, or too costly to conduct experimental research that manipulates one of the variables.

Correlational research can provide initial indications or additional support for theories about causal relationships.

Example: You want to investigate whether greenhouse gas emissions cause global warming. It is not practically possible to do an experiment that controls global emissions over time, but through observation and analysis you can show a strong correlation that supports the theory.

To test new measurement tools

You have developed a new instrument for measuring your variable, and you need to test its reliability or validity. Correlational research can be used to assess whether a tool consistently or accurately captures the concept it aims to measure.

Example: You develop a new scale to measure loneliness in young children based on anecdotal evidence during lockdowns. To validate this scale, you need to test whether it's actually measuring loneliness. You collect data on loneliness using three different measures, including the new scale, and test the degrees of correlations between the different measurements. Finding high correlations means that your scale is valid.

How to collect correlational data

There are many different methods you can use in correlational research. In the social and behavioral sciences, the most common data collection methods for this type of research include surveys, observations, and secondary data. It's important to carefully choose and plan your methods to ensure the reliability and validity of your results. You should carefully select a representative sample so that your data reflects the population you're interested in without bias.

Surveys

In survey research, you can use questionnaires to measure your variables of interest. You can conduct surveys online, by mail, by phone, or in person. Surveys are a quick, flexible way to collect standardized data from many participants, but it's important to ensure that your questions are worded in an unbiased way and capture relevant insights.

Example: To find out if there is a relationship between vegetarianism and income, you send out a questionnaire about diet to a sample of people from different income brackets. You statistically analyze the responses to determine whether vegetarians generally have higher incomes.

Naturalistic observation

This is a type of field research where you gather data about a behavior or phenomenon in its natural environment. This method often involves recording, counting, describing, and categorizing actions and events. Naturalistic observation can include both qualitative and quantitative elements, but to assess correlation, you collect data that can be analyzed quantitatively (e.g. frequencies, durations, scales, and amounts). Naturalistic observation lets you easily generalize your results to real world contexts, and you can study experiences that aren't replicable in lab settings. But data analysis can be time-consuming and unpredictable, and researcher bias may skew the interpretations.

Example: To find out if there is a correlation between gender and class participation, you observe college seminars, note the frequency and duration of students' contributions, and categorize them based on gender. You statistically analyze the data to determine whether men are more likely to speak up in class than women.

Secondary data

Instead of collecting original data, you can also use data that has already been collected for a different purpose, such as official records, polls, or previous studies. Using secondary data is inexpensive and fast, because data collection is complete. However, the data may be unreliable, incomplete or not entirely relevant, and you have no control over the reliability or validity of the data collection procedures.

Example: To find out if working hours are related to mental health, you use official national statistics and scientific studies from several different countries to combine data on average working hours and rates of mental illness. You statistically analyze the data to see if countries that work fewer hours have better mental health outcomes.

Examples of Correlational Research

Correlational research examples are numerous and highlight several instances where a correlational study may be carried out in order to determine the statistical behavioral trend with regards to the variables under consideration. Here are three case examples of correlational research.

- You want to know if wealthy people are less likely to be patient. From your experience, you believe that wealthy people are impatient. However, you want to establish a statistical pattern that proves or disproves your belief. In this case, you can carry out correlational research to identify a trend that links both variables.
- You want to know if there's a correlation between how much people earn and the number of children that they have. You do not believe that people with more spending power have more children than people with less spending power. You think that how much people earn hardly determines the number of children that they have. Yet, carrying out correlational research on both variables could reveal any correlational relationship that exists between them.
- You believe that domestic violence causes a brain hemorrhage. You cannot carry out an experiment as it would be unethical to deliberately subject people to domestic violence.

However, you can carry out correlational research to find out if victims of domestic violence suffer brain hemorrhage more than non-victims.

How to analyze correlational data

After collecting data, you can statistically analyze the relationship between variables using correlation or regression analyses, or both. You can also visualize the relationships between variables with a scatterplot. Different types of correlation coefficients and regression analyses are appropriate for your data based on their levels of measurement and distributions.

Correlation analysis

Using a correlation analysis, you can summarize the relationship between variables into a **correlation coefficient**: a single number that describes the strength and direction of the relationship between variables. With this number, you'll quantify the degree of the relationship between variables. The Pearson product-moment correlation coefficient, also known as Pearson's r , is commonly used for assessing a linear relationship between two quantitative variables. Correlation coefficients are usually found for two variables at a time, but you can use a multiple correlation coefficient for three or more variables.

Regression analysis

With a regression analysis, you can predict how much a change in one variable will be associated with a change in the other variable. The result is a **regression equation** that describes the line on a graph of your variables. You can use this equation to predict the value of one variable based on the given value(s) of the other variable(s). It's best to perform a regression analysis after testing for a correlation between your variables.

Correlation and causation

It's important to remember that correlation does not imply causation. Just because you find a correlation between two things doesn't mean you can conclude one of them causes the other for a few reasons.

Directionality problem

If two variables are correlated, it could be because one of them is a cause and the other is an effect. But the correlational research design doesn't allow you to infer which is which. To err on the side of caution, researchers don't conclude causality from correlational studies.

Example

You find a positive correlation between vitamin D levels and depression: people with low vitamin D levels are more likely to have depression. But you can't be certain about whether having low vitamin D levels causes depression, or whether having depression causes reduced intakes of vitamin D through lifestyle or appetite changes. Therefore, you can only conclude that there is a relationship between these two variables.

Third variable problem

A confounding variable is a third variable that influences other variables to make them seem causally related even though they are not. Instead, there are separate causal links between the confounder and each variable. In correlational research, there's limited or no researcher control over extraneous variables. Even if you statistically control for some potential confounders, there may still be other hidden variables that disguise the relationship between your study variables.

Example

You find a strong positive correlation between working hours and work-related stress: people with lower working hours report lower levels of work-related stress. However, this doesn't prove that lower working hours causes a reduction in stress.

There are many other variables that may influence both variables, such as average income, working conditions, and job insecurity. You might statistically control for these variables, but you can't say for certain that lower working hours reduce stress because other variables may complicate the relationship. Although a correlational study can't demonstrate causation on its own, it can help you develop a causal hypothesis that's tested in controlled experiments.

Lesson 13**CROSS-SECTIONAL RESEARCH DESIGN****Topic 013: Cross-sectional and longitudinal Research Designs****Cross-sectional Research Design**

A cross-sectional study is a type of research design in which you collect data from many different individuals at a single point in time. In cross-sectional research, you observe variables without influencing them. Cross-sectional study is defined as an observational study where data is collected as a whole to study a population at a single point in time to examine the relationship between variables of interest.

1. In an observational study, a researcher records information about the participants without changing anything or manipulating the natural environment in which they exist.
2. The most important feature of a cross-sectional study is that it can compare different samples at one given point in time. For example, a researcher wants to understand the relationship between joggers and level of cholesterol, he/she might want to choose two age groups of daily joggers, one group is below 30 but more than 20 and the other, above 30 but below 40 and compare these to cholesterol levels amongst non-joggers in the same age categories.
3. The researcher at this point in time can create subsets for gender, but cannot consider past cholesterol levels as this would be outside the given parameters for cross-sectional studies.
4. Cross-sectional studies allow the study of many variables at a given time. Researchers can look at age, gender, income etc in relation to jogging and cholesterol at a very little or no additional cost involved.
5. However, there is one downside to cross-sectional study, this type of study is not able to provide a definitive relation between cause and effect relation (a cause and effect relationship is one where one action (cause) makes another event happen (effect), for example, without an alarm, you might oversleep.)
6. This is majorly because cross-sectional study offers a snapshot of a single moment in time, this study doesn't consider what happens before or after. Therefore in this example stated above it is difficult to know if the daily joggers had low cholesterol levels before taking up jogging or if the activity helped them to reduce cholesterol levels that were previously high.
7. Researchers in economics, psychology, medicine, epidemiology, and the other social sciences all make use of cross-sectional studies in their work. **For example**, epidemiologists who are interested in the current prevalence of a disease in a certain subset of the population might use a cross-sectional design to gather and analyze the relevant data.

When to use a cross-sectional design

When you want to examine the prevalence of some outcome at a certain moment in time, a cross-sectional study is the best choice.

Example: You want to know how many families with children in Lahore City are currently low-income so you can estimate how much money is required to fund a free lunch program in public schools. Because all you need to know is the current number of low-income families, a cross-sectional study should provide you with all the data you require. Sometimes a cross-sectional study is the best choice for practical reasons – for instance, if you only have the time or money to collect cross-sectional data, or if the only data you can find to answer your research question was gathered at a single point in time. As cross-sectional studies are cheaper and less time-

consuming than many other types of study, they allow you to easily collect data that can be used as a basis for further research.

Descriptive vs analytical studies

Cross-sectional studies can be used for both analytical and descriptive purposes:

- An **analytical study** tries to answer how or why a certain outcome might occur.
- A **descriptive study** only summarizes said outcome using descriptive statistics.
- **Example:** You are studying child obesity. A descriptive study might look at the prevalence of obesity in children, while an analytical study might examine exercise and food habits in addition to obesity levels to explain why some children are much more likely to be obese than others.

How to perform a cross-sectional study

To implement a cross-sectional study, you can rely on data assembled by another source or collect your own. Governments often make cross-sectional datasets freely available online. Prominent examples include the censuses of several countries like the US or France, which survey a cross-sectional snapshot of the country's residents on important measures. International organisations like the World Health Organization or the World Bank also provide access to cross-sectional datasets on their websites. However, these datasets are often aggregated to a regional level, which may prevent the investigation of certain research questions. You will also be restricted to whichever variables the original researchers decided to study. If you want to choose the variables in your study and analyze your data on an individual level, you can collect your own data using research methods such as surveys. It's important to carefully design your questions and choose your sample.

Advantages of cross-sectional studies

Like any research design, cross-sectional studies have various benefits and drawbacks.

- Because you only collect data at a single point in time, cross-sectional studies are relatively cheap and less time-consuming than other types of research.
- Cross-sectional studies allow you to collect data from a large pool of subjects and compare differences between groups.
- Cross-sectional studies capture a specific moment in time. National censuses, for instance, provide a snapshot of conditions in that country at that time.

Disadvantages of cross-sectional studies

- It is difficult to establish cause-and-effect relationships using cross-sectional studies, since they only represent a one-time measurement of both the alleged cause and effect.
- Since cross-sectional studies only study a single moment in time, they cannot be used to analyze behavior over a period of time or establish long-term trends.
- The timing of the cross-sectional snapshot may be unrepresentative of behavior of the group as a whole. For instance, imagine you are looking at the impact of psychotherapy on an illness like depression. If the depressed individuals in your sample began therapy shortly before the data collection, then it might appear that therapy causes depression even if it is effective in the long term.

Longitudinal Research Design

In a longitudinal study, researchers repeatedly examine the same individuals to detect any changes that might occur over a period of time. Longitudinal studies are a type of correlational research in which

researchers observe and collect data on a number of variables without trying to influence those variables. While they are most commonly used in medicine, economics, and epidemiology, longitudinal studies can also be found in the other social or medical sciences. Longitudinal study, like the cross-sectional study, is also an observational study, in which data is gathered from the same sample repeatedly over an extended period of time. Longitudinal study can last from a few years to even decades depending on what kind of information needs to be obtained.

1. The benefit of conducting longitudinal study is that researchers can make notes of the changes, make observations and detect any changes in the characteristics of their participants. One of the important aspects here is that longitudinal study extends beyond a single frame in time. As a result, they can establish a proper sequence of the events occurred.
2. Continuing with the example, in longitudinal study a researcher wishes to look at the changes in cholesterol level in women above the age of 30 but below 40 years who have jogged regularly over the last 10 years. In longitudinal study setup, it would be possible to account for cholesterol levels at the start of the jogging regime, therefore longitudinal studies are more likely to suggest a cause-and-effect relationship.
3. Overall, research should drive the design, however, sometimes as the research progresses it helps determine which of the design is more appropriate. Cross-sectional studies can be done more quickly as compared to longitudinal studies. That's why a researcher may start off with cross-sectional study and if needed follow it up with longitudinal studies.

How long is a longitudinal study?

No set amount of time is required for a longitudinal study, so long as the participants are repeatedly observed. They can range from as short as a few weeks to as long as several decades. However, they usually last at least a year, oftentimes several.

One of the longest longitudinal studies, the Harvard Study of Adult Development, has been collecting data on the physical and mental health of a group of Boston men for over 80 years!

How to perform a longitudinal study

If you want to implement a longitudinal study, you have two choices: collecting your own data or using data already gathered by somebody else.

Using data from other sources

Many governments or research centers carry out longitudinal studies and make the data freely available to the general public. For example, anyone can access data from the 1970 British Cohort Study, which has followed the lives of 17,000 Brits since their births in a single week in 1970, through the UK Data Service website. These statistics are generally very trustworthy and allow you to investigate changes over a long period of time. However, they are more restrictive than data you collect yourself. To preserve the anonymity of the participants, the data collected is often aggregated so that it can only be analyzed on a regional level. You will also be restricted to whichever variables the original researchers decided to investigate. If you choose to go this route, you should carefully examine the source of the dataset as well as what data is available to you.

Collecting your own data

If you choose to collect your own data, the way you go about it will be determined by the type of longitudinal study you choose to perform. You can choose to conduct a retrospective or a prospective study.

- In a **retrospective study**, you collect data on events that have already happened.

- In a **prospective study**, you choose a group of subjects and follow them over time, collecting data in real time.

Retrospective studies are generally less expensive and take less time than prospective studies, but are more prone to measurement error. **Example:** In a retrospective study, you might look at past medical records of patients to see whether those who developed this cancer had previously smoked. In a prospective study, you might follow a group of both smokers and non-smokers over time to see if they develop cancer later on.

Advantages and disadvantages of longitudinal studies

Like any other research design, longitudinal studies have their tradeoffs: they provide a unique set of benefits, but also come with some downsides.

Advantages

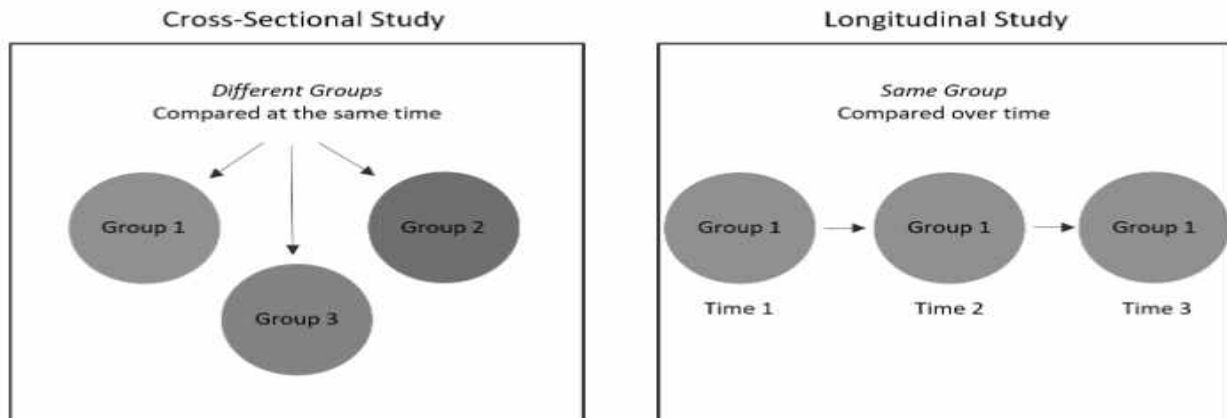
1. Longitudinal studies allow researchers to follow their subjects in real time. This means you can better establish the real sequence of events, allowing you insight into cause-and-effect relationships. **Example:** A cross-sectional study on the impact of police on crime might find that more police are associated with greater crime and wrongly conclude that police cause crime when it is the other way around. However, a longitudinal study would be able to observe the rise or fall in crime some time after increasing the number of police in an area.
2. Longitudinal studies also allow repeated observations of the same individual over time. This means any changes in the outcome variable cannot be attributed to differences between individuals. **Example:** You decide to study how a particular weight-training program affects athletic performance. If you choose a longitudinal study, the impact of natural talent on performance should be eliminated, since that would not change over the study period.
3. Prospective longitudinal studies eliminate the risk of recall bias, or the inability to correctly recall past events. **Example:** You are studying the effect of low-carb diets on weight loss. If you asked your subjects to remember how many carbs or how much they weighed at any point in time in the past, they might have difficulty doing so. In a longitudinal study, you can keep track of these variables in real time.

Disadvantages

1. Longitudinal studies are time-consuming and often more expensive than other types of studies, so they require significant commitment and resources to be effective. Since longitudinal studies repeatedly observe subjects over a period of time, any potential insights from the study can take a while to be discovered. **Example:** In the study examining the links between smoking and stomach cancer, you have to wait several years to see any results since the negative effects of smoking accumulate over decades.
2. Attrition, which occurs when participants drop out of a study, is common in longitudinal studies and may result in invalid conclusions. **Example:** In your study on the impact of low-carb diets on weight loss, participants who are not seeing much success might feel more discouraged and thus more likely to drop out. The diet might therefore appear to be more successful than it actually is!

Differences between Cross-Sectional Study and Longitudinal Study

Cross-sectional and longitudinal study both are types of observational study, where the participants are observed in their natural environment. There are no alteration or changes in the environment in which the participants exist.



Despite this marked similarity, there are distinctive differences between both these forms of study. Let us analyze the differences between cross-sectional study and longitudinal study.

Cross-sectional study	Longitudinal study
Cross-sectional studies are quick to conduct as compared to longitudinal studies.	Longitudinal studies may vary from a few years to even decades.
A cross-sectional study is conducted at a given point in time.	A longitudinal study requires a researcher to revisit participants of the study at proper intervals.
Cross-sectional study is conducted with different samples.	Longitudinal study is conducted with the same sample over the years.
Cross-sectional studies cannot pin down cause-and-effect relationship.	Longitudinal study can justify cause-and-effect relationship.
Multiple variables can be studied at a single point in time.	Only one variable is considered to conduct the study.
Cross-sectional study is comparatively cheaper.	Since the study goes on for years longitudinal study tends to get expensive.

Conclusion

It is true, study design greatly depends on the nature of research questions. Whenever a researcher decides to collect data by deploying surveys to his/her participants, what matters the most are the survey questions that are placed tactfully, so as to gather meaningful insights.

In other words, to know what kind of information a study should be able to collect is the first step in determining how to carry out the rest of the study. What steps need to be included and what can be given a pass.

Continuing from the example above, a researcher wants to establish a relation between the variables, “jogging” and “cholesterol” in this case, one of the first things that a researcher would need to establish in this kind of study is, to tell the most about the relationship. A few questions to ask would be, whether to compare cholesterol levels among different populations of joggers, non-joggers at the same point in time? Or to measure cholesterol levels in a single population of daily joggers over an extended period of time? The first approach typically requires a cross-sectional study and the second approach requires a longitudinal study.

Lesson 14**EXPERIMENTAL RESEARCH DESIGN****Topic 014: Experimental Research Design****Experimental Research Design**

Experimental research is the most familiar type of research design for individuals in the physical sciences and a host of other fields. This is mainly because experimental research is a classical scientific experiment, similar to those performed in high school science classes.

Imagine taking 2 samples of the same plant and exposing one of them to sunlight, while the other is kept away from sunlight. Let the plant exposed to sunlight be called sample A, while the latter is called sample B. If after the duration of the research, we find out that sample A grows and sample B dies, even though they are both regularly wetted and given the same treatment. Therefore, we can conclude that sunlight will aid growth in all similar plants.

The Types of Experimental Research Design

The types of experimental research design are determined by the way the researcher assigns subjects to different conditions and groups. They are of 3 types, namely; pre-experimental, quasi-experimental, and true experimental research.

1. Pre-experimental Research Design

In pre-experimental research design, either a group or various dependent groups are observed for the effect of the application of an independent variable which is presumed to cause change. It is the simplest form of experimental research design and is treated with no control group.

Although very practical, experimental research is lacking in several areas of the true-experimental criteria. The pre-experimental research design is further divided into three types

- **One-shot Case Study Research Design**

In this type of experimental study, only one dependent group or variable is considered. The study is carried out after some treatment which was presumed to cause change, making it a posttest study.

- **One-group Pretest-posttest Research Design:**

This research design combines both posttest and pretest study by carrying out a test on a single group before the treatment is administered and after the treatment is administered. With the former being administered at the beginning of treatment and later at the end.

- **Static-group Comparison:**

In a static-group comparison study, 2 or more groups are placed under observation, where only one of the groups is subjected to some treatment while the other groups are held static. All the groups are post-tested, and the observed differences between the groups are assumed to be a result of the treatment.

2. Quasi-experimental Research Design

The word "quasi" means partial, half, or pseudo. Therefore, the quasi-experimental research bearing a resemblance to the true experimental research, but not the same. In quasi-experiments, the participants are not randomly assigned, and as such, they are used in settings where randomization is difficult or impossible.

This is very common in educational research, where administrators are unwilling to allow the random selection of students for experimental samples.

Some examples of quasi-experimental research design include; the time series, no equivalent control group design, and the counterbalanced design.

3. True Experimental Research Design

The true experimental research design relies on statistical analysis to approve or disprove a hypothesis. It is the most accurate type of experimental design and may be carried out with or without a pretest on at least 2 randomly assigned dependent subjects.

The true experimental research design must contain a control group, a variable that can be manipulated by the researcher, and the distribution must be random. The classification of true experimental design include:

- **The posttest-only Control Group Design:** In this design, subjects are randomly selected and assigned to the 2 groups (control and experimental), and only the experimental group is treated. After close observation, both groups are post-tested, and a conclusion is drawn from the difference between these groups.
- **The pretest-posttest Control Group Design:** For this control group design, subjects are randomly assigned to the 2 groups, both are presented, but only the experimental group is treated. After close observation, both groups are post-tested to measure the degree of change in each group.
- **Solomon four-group Design:** This is the combination of the pretest-only and the pretest-posttest control groups. In this case, the randomly selected subjects are placed into 4 groups.

The first two of these groups are tested using the posttest-only method, while the other two are tested using the pretest-posttest method.

Examples of Experimental Research

Experimental research examples are different, depending on the type of experimental research design that is being considered. The most basic example of experimental research is laboratory experiments, which may differ in nature depending on the subject of research.

Administering Exams after the End of Semester

During the semester, students in a class are lectured on particular courses and an exam is administered at the end of the semester. In this case, the students are the subjects or dependent variables while the lectures are the independent variables treated on the subjects.

Only one group of carefully selected subjects are considered in this research, making it a pre-experimental research design example. We will also notice that tests are only carried out at the end of the semester, and not at the beginning. Further making it easy for us to conclude that it is a one-shot case study research.

Employee Skill Evaluation

Before employing a job seeker, organizations conduct tests that are used to screen out less qualified candidates from the pool of qualified applicants. This way, organizations can determine an employee's skill set at the point of employment. In the course of employment, organizations also carry out employee training to improve employee productivity and generally grow the organization. Further evaluation is carried out at the end of each training to test the impact of the training on employee skills, and test for improvement. Here, the subject is the

employee, while the treatment is the training conducted. This is a pretest-posttest control group experimental research example.

Conclusion

Experimental research designs are often considered to be the standard in research designs. This is partly due to the common misconception that research is equivalent to scientific experiments—a component of experimental research design. In this research design, one or more subjects or dependent variables are randomly assigned to different treatments (i.e. independent variables manipulated by the researcher) and the results are observed to conclude. One of the uniqueness of experimental research is in its ability to control the effect of extraneous variables. Experimental research is suitable for research whose goal is to examine cause-effect relationships, e.g. explanatory research. It can be conducted in the laboratory or field settings, depending on the aim of the research that is being carried out.

Lesson 15**ACTION RESEARCH DESIGN****Topic 015: Action Research Design****Action Research**

Action research can be defined as “an approach in which the action researcher and a client collaborate in the diagnosis of the problem and in the development of a solution based on the diagnosis”. In other words, one of the main characteristic traits of action research relates to collaboration between researcher and member of organisation in order to solve organizational problems. Action study assumes social world to be constantly changing, both, researcher and research being one part of that change.

Action Research Design

Action research design is an educational research involving collecting information regarding current educational programs and outcomes, analyzing the information, developing a plan to improve it, collecting changes after a new plan is implemented, and developing conclusions regarding the improvements. The main purpose of action research is to improve educational programs within schools.

Types of Action Researchers

Generally, action researches can be divided into three categories: positivist, interpretive and critical.

1. **Positivist approach to action research**, also known as ‘classical action research’ perceives research as a social experiment. Accordingly, action research is accepted as a method to test hypotheses in a real world environment.
2. **Interpretive action research**, also known as ‘contemporary action research’ perceives business reality as socially constructed and focuses on specifications of local and organisational factors when conducting the action research.
3. **Critical action research** is a specific type of action research that adopts critical approach towards business processes and aims for improvements.

Types of Action Research Design

The four main types of action research design are individual research, collaborative research, school-wide research and district-wide research.

4. Individual Research

Individual action research is research conducted by one teacher or staff member. This type of research is conducted to analyze a specific task. A teacher may wonder if implementing group activities within an English class will help improve learning. The teacher alone performs research by implementing a group activity for a certain length of time. After the action is performed, the teacher analyzes the results, implements changes, or discards the program if not found to be helpful.

5. Collaborative Research

Collaborative research involves a group of people researching a specified topic. With collaborative research, more than one person is involved in the implementation of the new program. Typically, a group of students, larger than just one class, are tested, and the results are analyzed. Many times collaborative research involves both teachers and the principal of

the school. This type of research offers the collaboration of many people working jointly on one subject. The joint collaboration often offers more benefits than an individual action research approach.

6. School-Wide Research

Action research programs are generally created from a problem found within an entire school. When a program is researched for an entire school, it is called school-wide action research. For this type of action research, a school may have concerns about a school-wide problem. This can be lack of parental involvement or research to increase students' performance in a certain subject. The entire staff works together through this research to study the problem, implement changes, and correct the problem or increase performance.

7. District-Wide Research

District-wide research is used for an entire school district. This type of action research is usually more community-based than the other types. This type may also be used to address organizational problems within the entire district. For district-wide research, staff from each school in the district, collaborates in correcting the problem or finding ways to improve the situation.

Features of Action Research

The following features of action research need to be taken into account when considering its suitability for any given study:

- It is applied in order to improve specific practices. Action research is based on action, evaluation and critical analysis of practices based on collected data in order to introduce improvements in relevant practices.
- This type of research is facilitated by participation and collaboration of number of individuals with a common purpose
- Such a research focuses on specific situations and their context

Advantages of Action Research

- High level of practical relevance of the business research;
- Can be used with quantitative, as well as, qualitative data;
- Possibility to gain in-depth knowledge about the problem.

Disadvantages of Action Research

- Difficulties in distinguishing between action and research and ensure the application of both;
- Delays in completion of action research due to a wide range of reasons are not rare occurrences
- Lack of repeatability and rigour

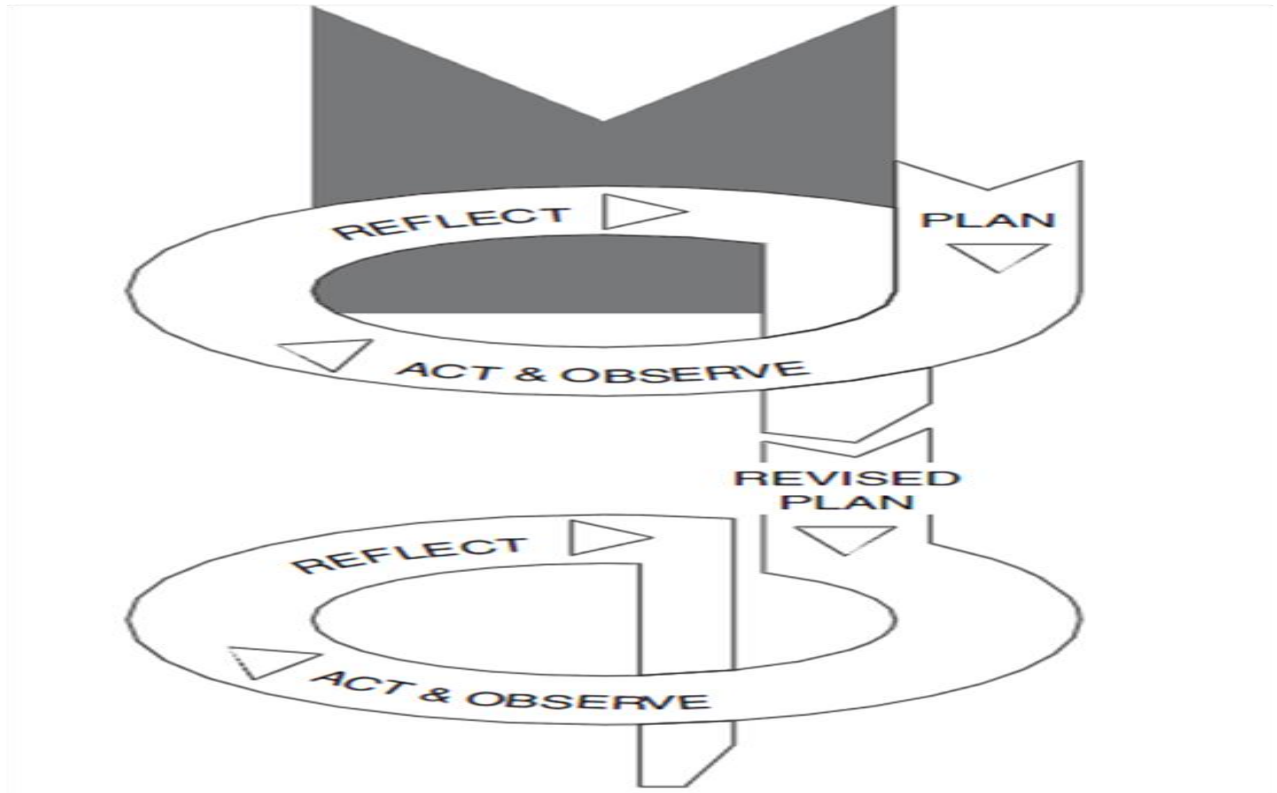
It is important to make a clear distinction between action research and consulting. Specifically, action research is greater than consulting in a way that action research includes both action and research, whereas business activities of consulting are limited action without the research.

Action Research Spiral

Action study is a participatory study consisting of spiral of following self-reflective cycles:

1. Planning in order to initiate change

2. Implementing the change (acting) and observing the process of implementation and consequences
3. Reflecting on processes of change and re-planning
4. Acting and observing
5. Reflecting



Action Research Spiral

Kemmis and McTaggart (2000) do acknowledge that individual stages specified in Action Research Spiral model may overlap, and initial plan developed for the research may become obsolete in short duration of time due to a range of factors. The main **advantage** of Action Research Spiral model relates to the opportunity of analysing the phenomenon in a greater depth each time, consequently resulting in greater level of understanding of the problem. **Disadvantages** of Action Research Spiral model include its assumption each process takes long time to be completed which may not always be the case.

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Lesson 16**MIXED METHOD RESEARCH****Topic 016: Mixed Method Research****Introduction**

The term “mixed methods” refers to an emergent methodology of research that advances the systematic integration, or “mixing,” of quantitative and qualitative data within a single investigation or sustained program of inquiry. The basic premise of this methodology is that such integration permits a more complete and synergistic utilization of data than do separate quantitative and qualitative data collection and analysis.

Definition

Mixed methods research is a procedure for collecting, analyzing and “mixing” both quantitative and qualitative methods in a single study or a series of studies to understand a research problem. -Creswell & Plano Clark(2011).

Aim of Mixed Method Research

The purpose of this form of research is that both qualitative and quantitative research, in combination, provide a better understanding of a research problem or issue than either research approach alone.

Use of Mixed Method Research in Different fields

Mixed methods research originated in the social sciences and has recently expanded into the health and medical sciences including fields such as nursing, family medicine, social work, mental health, pharmacy, allied health, and others. In the last decade, its procedures have been developed and refined to suit a wide variety of research questions (Creswell and Plano Clark, 2011).

Characteristics of Mixed Method Research

The core characteristics of a well-designed mixed methods study in research include the following:

1. Collecting and analyzing both quantitative (closed-ended) and qualitative (open-ended) data.
2. Using rigorous procedures in collecting and analyzing data appropriate to each method's tradition, such as ensuring the appropriate sample size for quantitative and qualitative analysis.
3. Integrating the data during data collection, analysis, or discussion.
4. Using procedures that implement qualitative and quantitative components either concurrently or sequentially, with the same sample or with different samples.
5. Framing the procedures within philosophical/theoretical models of research, such as within a social constructionist model that seeks to understand multiple perspectives on a single issue—for example, what patients, caregivers, clinicians, and practice staff would characterize as “high quality treatment” .

Mix Method Research Questions

A strong mixed methods study should contain the qualitative question, the quantitative question or hypothesis, and a mixed methods question. This configuration is necessary because mixed methods does not rely exclusively on either qualitative or quantitative research but on both forms of inquiry.

Mixed methods research question examples

- To what extent does the frequency of traffic accidents (*quantitative*) reflect cyclist perceptions of road safety (*qualitative*) in Amsterdam?
- How do student perceptions of their school environment (*qualitative*) relate to differences in test scores (*quantitative*)?
- How do interviews about job satisfaction at Company X (*qualitative*) help explain year-over-year sales performance and other KPIs (*quantitative*)?
- How can voter and non-voter beliefs about democracy (*qualitative*) help explain election turnout patterns (*quantitative*) in Town X?
- How do average hospital salary measurements over time (*quantitative*) help to explain nurse testimonials about job satisfaction (*qualitative*)?

Checklist for Mixed Method Research Design

Table 10.1 A Checklist of Questions for Designing a Mixed Methods Procedure

	Is a basic definition of mixed methods research provided?
	Are the reasons given for using both quantitative and qualitative data?
	Does the reader have a sense for the potential use of mixed methods research?
	Are the criteria identified for choosing a mixed methods design?
	Is the mixed methods design identified?
	Is a visual model presented that illustrates the research strategy?
	Is the proper notation used in presenting the visual model?
	Are procedures of data collection and analysis mentioned as they relate to the chosen design?
	Are the sampling strategies for both quantitative and qualitative data collection mentioned for the design?
	Are specific data analysis procedures indicated for the design?
	Are the procedures for validation mentioned for the design and for the quantitative and qualitative research?
	Is the narrative structure of the final dissertation or thesis mentioned, and does it relate to the type of mixed methods design being used?

When to use mixed methods research

Mixed methods research may be the right choice if your research process suggests that quantitative or qualitative data alone will not sufficiently answer your research question. There are several common reasons for using mixed methods research:

- **Generalizability:** Qualitative research usually has a smaller sample size, and thus is not generalizable. In mixed methods research, this comparative weakness is mitigated by the comparative strength of “large N,” externally valid quantitative research.
- **Contextualization:** Mixing methods allows you to put findings in context and add richer detail to your conclusions. Using qualitative data to illustrate quantitative findings can help “put meat on the bones” of your analysis.
- **Credibility:** Using different methods to collect data on the same subject can make your results more credible. If the qualitative and quantitative data converge, this strengthens the validity of your conclusions. This process is called **triangulation**.

As you formulate your research question, try to directly address how qualitative and quantitative methods will be combined in your study. If your research question can be sufficiently answered via standalone quantitative or qualitative analysis, a mixed methods approach may not be the right fit.

Research example: You want to research **cycling safety in high-traffic areas of Amsterdam**. If you're interested in the frequency of accidents and where they occur, this could be a straightforward quantitative analysis. If you're interested in the nature of complaints submitted by cyclists, or their perceptions about cycling in particular areas, then a qualitative approach may fit best. But mixed methods might be a good choice if you want to meaningfully integrate both of these questions in one research study. For example, you could use a mixed methods design to investigate whether areas perceived as dangerous have high accident rates, or to explore why specific areas are more dangerous for cyclists than others. Keep in mind that mixed methods research doesn't just mean collecting both types of data; you need to carefully consider the relationship between the two and how you'll integrate them into coherent conclusions. Mixed methods can be very challenging to put into practice, so it's a less common choice than standalone qualitative or quantitative research.

Mixed methods research designs

There are different types of mixed methods research designs. The differences between them relate to the aim of the research, the timing of the data collection, and the importance given to each data type.

As you design your mixed methods study, also keep in mind:

- Your research approach (inductive vs deductive)
- Your research questions
- What kind of data is already available for you to use
- What kind of data you're able to collect yourself.

The four major mixed methods designs are identified below and compared in terms of their purposes, strengths and weaknesses. Examples of each design are also described.

1. Convergent parallel

In a convergent parallel design, you collect quantitative and qualitative data at the same time and analyze them separately. After both analyses are complete, compare your results to draw overall conclusions. In this design only one data collection phase is used, during which quantitative and qualitative data collection and analysis are conducted separately yet concurrently. The findings are integrated during the interpretation phase of the study. Usually, equal priority is given to both types of research.

When to use it?

- To develop a more complete understanding of a topic or phenomenon.
- To cross-validate or corroborate findings.

Strengths

- Provides well-validated and substantiated findings.
- Compared to sequential designs, data collection takes less time.

Weaknesses

- Requires great effort and expertise to adequately use two separate methods at the same time.
- It can be difficult to compare the results of two analysis using data of different forms.

- It may be unclear how to resolve discrepancies that arise while comparing the results.
- Given that data collection is conducted concurrently, results of one method (e.g., interview) cannot be integrated in the other method (e.g., survey).

Example 1: The researcher uses a survey to assess people's self-reported food safety practices and also observes those practices in their natural environment. By comparing the two types of data, the researcher can see if there is a match between what people think they are doing and what they are actually doing in terms of food safety practices.

Example 2: In your research on cycling safety in Amsterdam, you undertake both sides of your research simultaneously:

- On the qualitative side, you analyze cyclist complaints via the city's database and on social media to find out which areas are perceived as dangerous and why.
- On the quantitative side, you analyze accident reports in the city's database to find out how frequently accidents occur in different areas of the city.

When you finish your data collection and analysis, you then compare results and tie your findings together.

2. Embedded Research Design

In an embedded design, you collect and analyze both types of data at the same time, but within a larger quantitative or qualitative design. One type of data is secondary to the other. This is a good approach to take if you have limited time or resources. You can use an embedded design to strengthen or supplement your conclusions from the primary type of research design. In this design only one data collection phase is used, during which a predominant method (quantitative or qualitative) nests or embeds the other less priority method (qualitative or quantitative, respectively). This nesting may mean that the embedded method addresses a different question than the dominant method or seeks information from different levels. The data collected from the two methods are mixed during the analysis phase of the project.

When to use it?

- To gain broader and in-depth perspectives on a topic.
- To offset possible weaknesses inherent to the predominant method.

Strengths:

- Two types of data are collected simultaneously, reducing time and resources (e.g., number of participants).
- Provides a study with the advantages of both quantitative and qualitative data.

Weaknesses:

- The data needs to be transformed in some way so that both types of data can be integrated during the analysis, which can be difficult.
- Inequality between different methods may result in unequal evidence within the study, which can be a disadvantage when interpreting the results.

Example 1: The researcher collects data to assess people's knowledge and risk perceptions about genetically modified food by using a survey instrument that mixes qualitative (open-ended) and quantitative (closed-ended) questions, and both forms of data are integrated and analysed.

Example 2: As part of a quantitative study testing whether the number of cyclist complaints about an area correlates with the number of accidents, you could “embed” a series of qualitative interviews with cyclists who submitted complaints to further strengthen your argument. The bulk of your research remains quantitative.

Explanatory sequential

In an explanatory sequential design, your quantitative data collection and analysis occurs first, followed by qualitative data collection and analysis. You should use this design if you think your qualitative data will explain and contextualize your quantitative findings. This design involves the collection and analysis of quantitative data followed by the collection and analysis of qualitative data. The priority is given to the quantitative data, and the findings are integrated during the interpretation phase of the study.

When to use it?

- To help explain, interpret or contextualize quantitative findings.
- To examine in more detail unexpected results from a quantitative study.

Strengths:

- Easy to implement because the steps fall into clear separate stages.
- The design is easy to describe and the results easy to report.

Weaknesses:

- Requires a substantial length of time to complete all data collection given the two separate phases.

Example 1: The researcher collects data about people’s risk and benefit perceptions of red meat using a survey and follows up with interviews with a few individuals who participated in the survey to learn in more detail about their survey responses (e.g., to understand the thought process of people with low risk perceptions).

Example 2: You analyze the accident statistics first and draw preliminary conclusions about which areas are most dangerous. Based on these findings, you conduct interviews with cyclists in high-accident areas and analyze complaints qualitatively. You can utilize the qualitative data to explain why accidents occur on specific roads, and take a deep dive into particular problem areas.

Exploratory sequential

In an exploratory sequential design, qualitative data collection and analysis occurs first, followed by quantitative data collection and analysis. You can use this design to first **explore** initial questions and develop hypotheses. Then you can use the quantitative data to test or confirm your qualitative findings. In this design, qualitative data collection and analysis is followed by quantitative data collection and analysis. The priority is given to the qualitative aspect of the study, and the findings are integrated during the interpretation phase of the study.

When to use it?

- To explore a phenomenon and to expand on qualitative findings.
- To test elements of an emergent theory resulting from the qualitative research.

- To generalize qualitative findings to different samples in order to determine the distribution of a phenomenon within a chosen population.
- To develop and test a new instrument

Strengths:

- Easy to implement because the steps fall into clear, separate stages.
- The design is easy to describe and the results easy to report.

Weaknesses:

- Requires a substantial length of time to complete all data collection given the two separate phases.
- It may be difficult to build from the qualitative analysis to the subsequent data collection.

Example 1: The researcher explores people's beliefs and knowledge regarding nutritional information by starting with in-store interviews and then uses an analysis of the information to develop a survey instrument that is administered later to a sample from a population.

Example 2: You first interview cyclists to develop an initial understanding of problem areas, and draw preliminary conclusions. Then you analyze accident statistics to test whether cyclist perceptions line up with where accidents occur.

Types of mixed methods research designs

When deciding what type of mixed methods design to use, it is important to take into account the overall purpose of the research (e.g., exploration or generalization), the specific research questions, and the strengths and weaknesses of each design.

Once a mixed methods research design has been selected, one has to decide which specific research methods and instruments/measures should be incorporated/mixed in the research program. This decision should be determined by the overall purpose of the research (e.g., exploration, explanation, theory-building, theory-testing, and generalization), the specific research questions, and the advantages and disadvantages of each research method.

Advantages of Mixed Method Research

Using a mixed methods study has several advantages, which we discuss below.

Compares quantitative and qualitative data. Mixed methods are especially useful in understanding contradictions between quantitative results and qualitative findings.

Reflects participants' point of view. Mixed methods give a voice to study participants and ensure that study findings are grounded in participants' experiences.

Fosters scholarly interaction. Such studies add breadth to multidisciplinary team research by encouraging the interaction of quantitative, qualitative, and mixed methods scholars.

Provides methodological flexibility. Mixed methods have great flexibility and are adaptable to many study designs, such as observational studies and randomized trials, to elucidate more information than can be obtained in only quantitative research.

Collects rich, comprehensive data. Mixed methods also mirror the way individuals naturally collect information—by integrating quantitative and qualitative data. For example, sports stories frequently integrate quantitative data (scores or number of errors) with qualitative data (descriptions and images of highlights) to provide a more complete story than either method would alone.

Disadvantages of Mixed Method Research

Mixed methods studies are challenging to implement, especially when they are used to evaluate complex interventions such as a PCMH model. Below we discuss several challenges.

Increases the complexity of evaluations. Mixed methods studies are complex to plan and conduct. They require careful planning to describe all aspects of research, including the study sample for qualitative and quantitative portions (identical, embedded, or parallel); timing (the sequence of qualitative and quantitative portions); and the plan for integrating data. Integrating qualitative and quantitative data during analysis is often a challenging phase for many researchers.

Relies on a multidisciplinary team of researchers. Conducting high-quality mixed methods studies requires a multidisciplinary team of researchers who, in the service of the larger study, must be open to methods that may not be their area of expertise. Finding qualitative experts who are also comfortable discussing quantitative analyses and vice versa can be challenging in many environments. Given that each method must adhere to its own standards for rigor, ensuring appropriate quality of each component of a mixed methods study can be difficult. For example, quantitative analyses require much larger sample sizes to obtain statistical significance than do qualitative analyses, which require meeting goals of saturation (not uncovering new information from conducting more interviews) and relevance. Embedded samples, in which a qualitative subsample is embedded within a larger quantitative sample, can be useful in cases of inadequate statistical power.

Requires increased resources. Finally, mixed methods studies are labor intensive and require greater resources and time than those needed to conduct a single method study.

References

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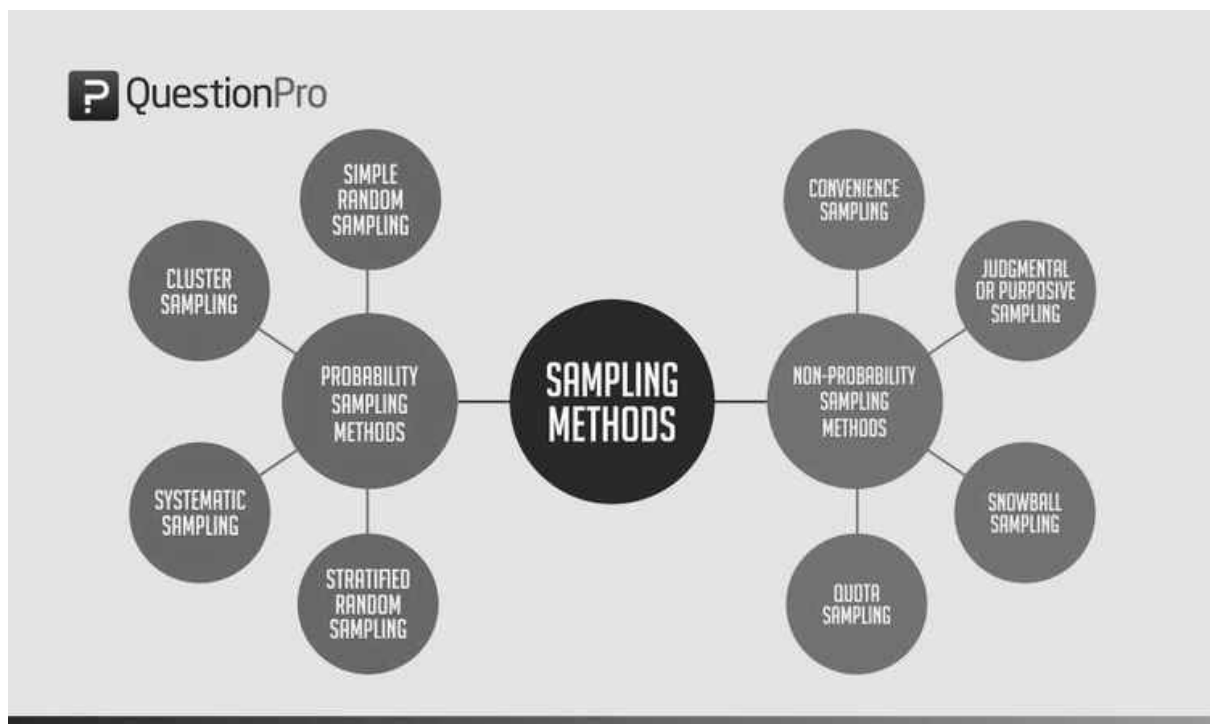
Lesson 17SAMPLING IN QUANTITATIVE RESEARCHTopic 017: Sampling in Quantitative Research**Sampling**

Sampling is a technique of selecting individual members or a subset of the population to make statistical inferences from them and estimate characteristics of the whole population.

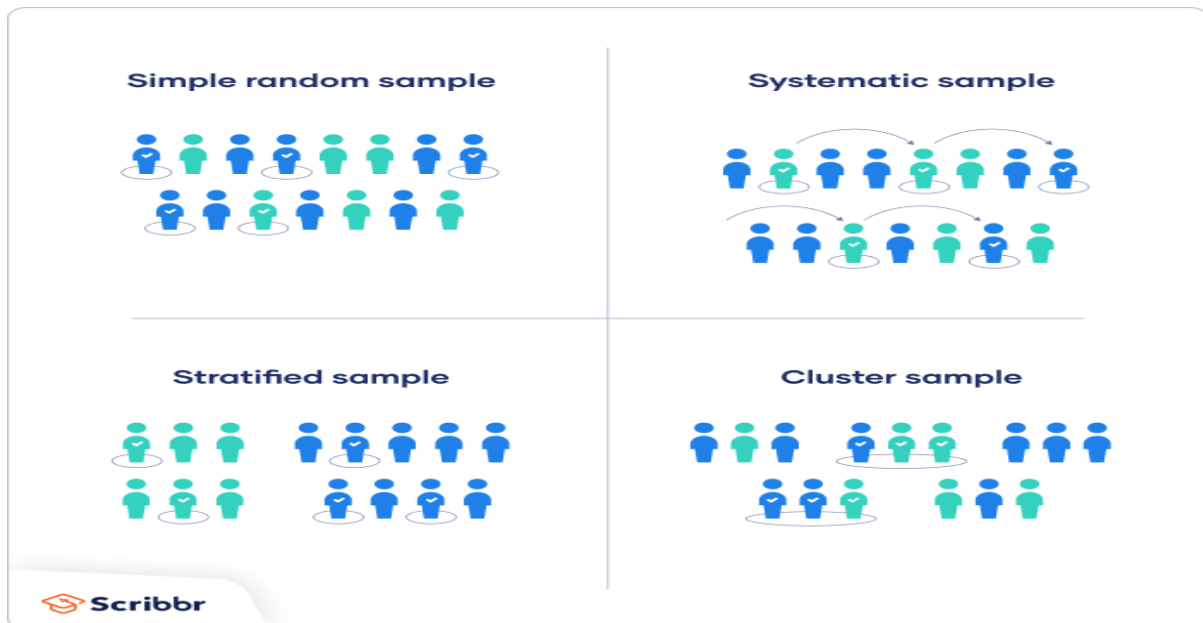
Types of sampling

Sampling in market research is of two types – probability sampling and non-probability sampling. Let's take a closer look at these two methods of sampling.

1. **Probability sampling:** Probability sampling is a sampling technique where a researcher sets a selection of a few criteria and chooses members of a population randomly. All the members have an equal opportunity to be a part of the sample with this selection parameter.
2. **Non-probability sampling:** In non-probability sampling, the researcher chooses members for research at random. This sampling method is not a fixed or predefined selection process. This makes it difficult for all elements of a population to have equal opportunities to be included in a sample.

**Sampling in Quantitative Research**

Probability sampling means that every member of the population has a chance of being selected. It is mainly used in quantitative research. If you want to produce results that are representative of the whole population, probability sampling techniques are the most valid choice. There are four main types of probability sample.



1. Simple random sampling

In a simple random sample, every member of the population has an equal chance of being selected. Your sampling frame should include the whole population.

To conduct this type of sampling, you can use tools like random number generators or other techniques that are based entirely on chance.

Example 1: You want to select a simple random sample of 100 employees of Company X. You assign a number to every employee in the company database from 1 to 1000, and use a random number generator to select 100 numbers.

Example 2: In an organization of 500 employees, if the HR team decides on conducting team building activities, it is highly likely that they would prefer picking chits out of a bowl. In this case, each of the 500 employees has an equal opportunity of being selected.

2. Systematic sampling

Systematic sampling is similar to simple random sampling, but it is usually slightly easier to conduct. Every member of the population is listed with a number, but instead of randomly generating numbers, individuals are chosen at regular intervals.

Example 1: All employees of the company are listed in alphabetical order. From the first 10 numbers, you randomly select a starting point: number 6. From number 6 onwards, every 10th person on the list is selected (6, 16, 26, 36, and so on), and you end up with a sample of 100 people. If you use this technique, it is important to make sure that there is no hidden pattern in the list that might skew the sample. For example, if the HR database groups employees by team, and team members are listed in order of seniority, there is a risk that your interval might skip over people in junior roles, resulting in a sample that is skewed towards senior employees.

Example 2: A researcher intends to collect a systematic sample of 500 people in a population of 5000. He/she numbers each element of the population from 1-5000 and will choose every 10th individual to be a part of the sample (Total population/ Sample Size = $5000/500 = 10$).

3. Stratified sampling

Stratified sampling involves dividing the population into subpopulations that may differ in important ways. It allows you draw more precise conclusions by ensuring that every subgroup

is properly represented in the sample. To use this sampling method, you divide the population into subgroups (called strata) based on the relevant characteristic (e.g. gender, age range, income bracket, job role). Based on the overall proportions of the population, you calculate how many people should be sampled from each subgroup. Then you use random or systematic sampling to select a sample from each subgroup.

Example 1: The Company has 800 female employees and 200 male employees. You want to ensure that the sample reflects the gender balance of the company, so you sort the population into two strata based on gender. Then you use random sampling on each group, selecting 80 women and 20 men, which gives you a representative sample of 100 people.

Example 2: A researcher looking to analyze the characteristics of people belonging to different annual income divisions will create strata (groups) according to the annual family income. Eg – less than \$20,000, \$21,000 – \$30,000, \$31,000 to \$40,000, \$41,000 to \$50,000, etc. By doing this, the researcher concludes the characteristics of people belonging to different income groups. Marketers can analyze which income groups to target and which ones to eliminate to create a roadmap that would bear fruitful results.

Proportionate versus Disproportionate If the number of sampling units drawn from each stratum is in proportion to the relative population size of the stratum, the sample is proportionate stratified sampling. Sometime, however, a disproportionate stratified sample will be selected to ensure an adequate number of sampling units in every stratum. In a disproportionate, sample size for each stratum is not allocated in proportion to the population size, but is dictated by analytical considerations.

4. Cluster sampling

Cluster sampling also involves dividing the population into subgroups, but each subgroup should have similar characteristics to the whole sample. Instead of sampling individuals from each subgroup, you randomly select entire subgroups. If it is practically possible, you might include every individual from each sampled cluster. If the clusters themselves are large, you can also sample individuals from within each cluster using one of the techniques above. This is called multistage sampling. This method is good for dealing with large and dispersed populations, but there is more risk of error in the sample, as there could be substantial differences between clusters. It's difficult to guarantee that the sampled clusters are really representative of the whole population.

Example 1: The Company has offices in 10 cities across the country (all with roughly the same number of employees in similar roles). You don't have the capacity to travel to every office to collect your data, so you use random sampling to select 3 offices – these are your clusters.

Example 2: if the United States government wishes to evaluate the number of immigrants living in the Mainland US, they can divide it into clusters based on states such as California, Texas, Florida, Massachusetts, Colorado, Hawaii, etc. This way of conducting a survey will be more effective as the results will be organized into states and provide insightful immigration data.

Double Sampling

This plan is adopted when further information is needed from a subset of the group from which some information has already been collected for the same study. A sampling design where initially a sample is used in a study to collect some preliminary information of interest, and later a sub-sample of this primary sample is used to examine the matter in more detail, is called double sampling.

FOUR TYPES OF PROBABILITY SAMPLES

<i>Type of Sample</i>	<i>Technique</i>
Cluster	Create a sampling frame for large cluster units, draw a random sample of the cluster units, create a sampling frame for cases within each selected cluster unit, then draw a random sample of cases, and so forth.
Simple random	Create a sampling frame for all cases and then select cases using a purely random process (e.g., random-number table or computer program).
Stratified	Create a sampling frame for each of several categories of cases, draw a random sample from each category, and then combine the several samples.
Systematic	Create a sampling frame, calculate the sampling interval $1/k$, choose a random starting place, and then take every $1/k$ case.

Uses of probability sampling

There are multiple uses of probability sampling:

- **Reduce Sample Bias:** Using the probability sampling method, the bias in the sample derived from a population is negligible to non-existent. The selection of the sample mainly depicts the understanding and the inference of the researcher. Probability sampling leads to higher quality data collection as the sample appropriately represents the population.
- **Diverse Population:** When the population is vast and diverse, it is essential to have adequate representation so that the data is not skewed towards one demographic. For example, if Square would like to understand the people that could make their point-of-sale devices, a survey conducted from a sample of people across the US from different industries and socio-economic backgrounds helps.
- **Create an Accurate Sample:** Probability sampling helps the researchers plan and create an accurate sample. This helps to obtain well-defined data.

What is the Appropriate Sample Design?

A researcher who must make a decision concerning the most appropriate sample design for a specific project will identify a number of sampling criteria and evaluate the relative importance of each criterion before selecting a sample design. The most common criteria are:

Degree of Accuracy

Selecting a representative sample is, of course, important to all researchers. However, the error may vary from project to project, especially when cost saving or another benefit may be a trade-off for reduction in accuracy.

Resources

The costs associated with the different sampling techniques vary tremendously. If the researcher's financial and human resources are restricted, this limitation of resources will eliminate certain methods. For a graduate student working on a master's thesis, conducting a national survey is almost always out of the question because of limited resources. Managers usually weigh the cost of research versus the value of information often will opt to save money by using non-probability sampling design rather than make the decision to conduct no research at all.

Advance Knowledge of the Population

Advance knowledge of population characteristics, such as the availability of lists of population members, is an important criterion. A lack of adequate list may automatically rule out any type of probability sampling.

National versus Local Project

Geographic proximity of population elements will influence sample design. When population elements are unequally distributed geographically, a cluster sampling may become more attractive.

Need for Statistical Analysis

The need for statistical projections based on the sample is often a criterion. Non-probability sampling techniques do not allow researcher to use statistical analysis to project the data beyond the sample.

Lesson 18**SAMPLING FRAME, SAMPLING SIZE, ERROR****Topic 018: Sampling Frame, Sampling Size, Error****Introduction**

A sample is a subset, or some part, of a larger whole. A larger whole could be anything out which sample is taken. That „whole“ could be a bucket of water, a bag of sugar, a group of organizations, a group of students, a group of customers, or a group mid-level managers in an organization. A complete group of entities sharing some common set of characteristics is population. In other words, the totality out of which sample is drawn is referred to as population.

Why we draw a sample?**1. Saves Cost, Labor, and Time**

Applied research projects usually have budget and time constraints. Since sample can save financial cost as well as time, therefore, to go for sample study is pragmatic. Of course, a researcher investigating a population with an extremely small number of population elements may elect to conduct a study on the total population rather than a sample because cost, labor, and time constraints are relatively insignificant. Although sample study cuts costs, reduces labor requirements, and gathers vital information quickly, yet there could be other reasons.

2. Quality Management/supervision

Professional fieldworkers are a scarce commodity. In a large study rather than employing less qualified staff it may be advisable to do a sample study and employ highly qualified professional fieldworkers. It can certainly affect the quality of the study. At the same time it may be easier to manage a small group and produce quality information. Supervision, record keeping, training, and so forth would all be more difficult in a very large study.

3. Accurate and Reliable Results

Another major reason for sampling is that samples, if properly selected, are sufficiently accurate in most of the cases. If the elements of a population are quite similar, only a small sample is necessary to accurately portray the characteristics of interest. Most of us have had blood samples taken from the finger, the arm, or another part of body. The assumption is that blood is sufficiently similar throughout the body, the characteristics of the blood can be determined on the basis of sample. When the elements of population are highly homogenous, samples are highly representative of the population. Under these circumstances almost any sample is as good as another. Samples may be more accurate than census. In a census study of large population there is a greater likelihood of non-sampling errors. In a survey mistakes may occur that are unrelated to the selection of people in the study. For example, a response may be coded incorrectly, or the keyboard operator might make data entry error. Interviewer mistakes, tabulation errors, and other non-sampling errors may increase during census because of the increased volume of work. In sample increased accuracy is possible because the fieldwork and tabulation of the data can be closely supervised than would be possible in a census. In field survey, a small, well trained, closely supervised group may do a more careful and accurate job of collecting information than a large group of nonprofessional interviewers trying to contact everyone.

4. Sampling may be the Only Way

Many research projects, especially those in quality control testing, require the destruction of the items being tested. If the manufacturer of firecrackers wished to find out whether each product met a specific production standard, there would be no product left after testing. Similarly, consider the case of electric bulbs. In testing the life of bulbs, if we were to burn every bulb produced, there would be none left to sell. This is destructive sampling.

5. Determine the Period of Study

Interviewing every element of a large population without sampling requires lot of time, may be a year or more. In such a long period study, even the seasonal variation may influence the response pattern of the respondents. For example, if the study was aimed at measuring the level of unemployment in a given large city, the unemployment rate produced by the survey data would not refer to the city as of the beginning of interviewing or as of the end. Researcher may be forced to attribute the unemployment to some hypothetical date, representing to the midpoint of the study period. Hence it will be difficult to determine the exact timing to which the data of the study pertains.

Sampling Terminology

There are a number of technical terms used in books on research and statistics which need explanation. Some of the important terms are:

Element

An element is that unit about which information is collected and which provides the basis of analysis. Typically, in survey research, elements are people or certain types of people. It is that unit about which information is collected and that provides the basis of analysis. It can be a person, groups, families, organizations, corporations, communities, and so forth.

Population

A population is the theoretically specified aggregation of study elements. It is translating the abstract concept into workable concept. For example, let us look at the study of “college students.” Theoretically who are the college students? They might include students registered in government colleges and/or private colleges, students of intermediate classes and/or graduate classes, students of professional colleges and/or non-professional colleges, and many other variations. In this way the pool of all available elements is population.

Target Population

Out of the conceptual variations what exactly the researcher wants to focus on. This may also be called a target population. Target population is the complete group of specific population elements relevant to the research project. Target population may also be called survey population i.e. that aggregation of elements from which the survey sample is actually selected. At the outset of the sampling process, it is vitally important to carefully define the target population so that the proper source from which the data is to be collected can be identified. In our example of „college students” finally we may decide to study the college students from government institutions located in Lahore, who are studying social sciences, who are aged 19 years of age, and hailing from rural areas.

Sampling Frame

In actual practice the sample will be drawn from a list of population elements that is often different from the target population that has been defined. A sampling frame is the list of elements from which the sample may be drawn. A simple example could be listing of all college

students meeting the criteria of target population and who are enrolled on the specified date. A sampling frame is also called the working population because it provides the list that can be worked with operationally. In our example, such a list could be prepared with help of the staff of the selected colleges.

Sampling Frame Error

A sampling frame error occurs when certain sample elements are excluded or when the entire population is not accurately represented in the sampling frame. The error that occurs when certain sample elements are not listed or available and are not represented in the sampling frame.

Sampling Unit A sampling unit is that element or set of elements considered for selection in some stage of sampling. Sampling may be done in single stage or in multiple stages. In a simple, single-stage sample, the sampling units are the same as the elements. In more complex samples, however, different levels of sampling units may be employed. For example, a researcher may select a sample of Mohallahs in a city, and then select a sample of households from the selected Mohallahs, and finally may select a sample of adults from the selected households. The sampling units of these three stages of sampling are respectively Mohallah, households, and adults, of which the last of these are the elements. More specifically, the terms “primary sampling units,” “secondary sampling units,” and “final sampling units” would be used to designate the successive stages.

Observation Unit

An observation unit, or unit of data collection, is an element or aggregation of elements from which the information is collected. Often the unit of analysis and unit of observation are the same – the individual person – but this need not be the case. Thus the researcher may interview heads of household (the observation units) to collect information about every member of the household (the unit of analysis).

Parameter A parameter is the summary description of a given variable in a population. The mean income of all families in a city and the age distribution of the city’s population are parameters. An important part of survey research involves the estimation of population parameters on the basis of sample observation.

Statistic A statistic is the summary description of a given variable in a survey sample. Thus the mean income computed from the survey sample and the age distribution of that sample are statistics. Sample statistics are used to make estimates of the population parameters.

The Cochran formula allows you to calculate an ideal sample size given a desired level of precision, desired confidence level, and the estimated proportion of the attribute present in the population. Cochran’s formula is considered especially appropriate in situations with **large populations**. A sample of any given size provides more information about a smaller population than a larger one, so there’s a ‘correction’ through which the number given by Cochran’s formula can be reduced if the whole population is relatively small.

Sample Size

A sample size is a part of the population chosen for a survey or experiment. For example, you might take a survey of dog owner’s brand preferences. You won’t want to survey *all* the millions of dog owners in the country (either because it’s too expensive or time consuming), so you take a sample size. That may be several thousand owners. The sample size is a *representation* of all dog owner’s brand preferences. If you choose your sample wisely, it will be a good representation.

How to Find a Sample Size in Statistics

A sample is a percentage of the total population in statistics. You can use the data from a sample to make inferences about a population as a whole. For example, the standard deviation of a sample can be used to approximate the standard deviation of a population. Finding a sample size can be one of the most challenging tasks in statistics and depends upon many factors including the size of your original population.

General Tips

Step 1: Conduct a Survey

if you have a small population. A “small” population will depend on your budget and time constraints. For example, it may take a day to take a census of a student body at a small private university of 1,000 students but you may not have the time to survey 10,000 students at a large state university.

Step 2: Use a sample size from a similar study

Chances are, your type of study has already been undertaken by someone else. You’ll need access to academic databases to search for a study (usually your school or college will have access). A pitfall: you’ll be relying on someone else correctly calculating the sample size. Any errors they have made in their calculations will transfer over to your study.

Step 3: Use a table

To find your sample size. If you have a fairly generic study, then there is probably a table for it. For example, if you have a clinical study, you may be able to use a table published in *Machin et. al’s Sample Size Tables for Clinical Studies, Third Edition*.

Step 4: Use a sample size calculator

Various calculators are available online, some simple, some more complex and specialized. For example, this calculator is for group- or cluster-randomized trials (GRTs).

Step 5: Use a formula.

There are many different formulas you can use, depending on what you know (or don’t know) about your population. If you know some parameters about your population (like a known standard deviation), you can use the techniques below. If you don’t know much about your population, use Slovin’s formula. ($n = N / (1 + Ne^2)$)

Sample Size for Known Population

Taro Yamne’s Sample Size Formula

Yamane’s Formula

Yamane’s formula is:

$$n = \frac{N}{1 + N(e)^2}$$

Where:

- e = precision level
- N = population size.

Cochran’s Sample Size Formula

The Cochran formula is:

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where:

- e is the desired level of precision (i.e. the margin of error),
- p is the (estimated) proportion of the population which has the attribute in question,
- q is $1 - p$.

Sampling Error

A sampling error is a statistical error that occurs when an analyst does not select a sample that represents the entire population of data. As a result, the results found in the sample do not represent the results that would be obtained from the entire population. Sampling is an analysis performed by selecting a number of observations from a larger population. The method of selection can produce both sampling errors and non-sampling errors.

- A sampling error occurs when the sample used in the study is not representative of the whole population.
- Sampling is an analysis performed by selecting a number of observations from a larger population.
- Even randomized samples will have some degree of sampling error because a sample is only an approximation of the population from which it is drawn.
- The prevalence of sampling errors can be reduced by increasing the sample size.
- Random sampling is an additional way to minimize the occurrence of sampling errors.
- In general, sampling errors can be placed into four categories: population-specific error, selection error, sample frame error, or non-response error.
- Population from which it is drawn.

Types of Sampling Errors

There are different categories of sampling errors.

1. Population-Specific Error

A population-specific error occurs when a researcher doesn't understand who to survey.

2. Selection Error

Selection error occurs when the survey is self-selected, or when only those participants who are interested in the survey respond to the questions. Researchers can attempt to overcome selection error by finding ways to encourage participation.

3. Sample Frame Error

A sample frame error occurs when a sample is selected from the wrong population data.

4. Non-response Error

A non-response error occurs when a useful response is not obtained from the surveys because researchers were unable to contact potential respondents (or potential respondents refused to respond).

Examples of Sampling Errors

Assume that XYZ Company provides a subscription-based service that allows consumers to pay a monthly fee to stream videos and other types of programming via an Internet connection.

- The firm wants to survey homeowners who watch at least 10 hours of programming via the Internet per week and that pay for an existing video streaming service. XYZ wants to determine what percentage of the population is interested in a lower-priced subscription service. If XYZ does not think carefully about the sampling process, several types of sampling errors may occur.
- A population specification error would occur if XYZ Company does not understand the specific types of consumers who should be included in the sample. For example, if XYZ creates a population of people between the ages of 15 and 25 years old, many of those consumers do not make the purchasing decision about a video streaming service because they do not work full-time. On the other hand, if XYZ put together a sample of working adults who make purchase decisions, the consumers in this group may not watch 10 hours of video programming each week.
- Selection error also causes distortions in the results of a sample. A common example is a survey that only relies on a small portion of people who immediately respond. If XYZ makes an effort to follow up with consumers who don't initially respond, the results of the survey may change. Furthermore, if XYZ excludes consumers who don't respond right away, the sample results may not reflect the preferences of the entire population.

Sampling Error vs. Non-sampling Error

There are different types of errors that can occur when gathering statistical data. Sampling errors are the seemingly random differences between the characteristics of a sample population and those of the general population. Sampling errors arise because sample sizes are inevitably limited. (It is impossible to sample an entire population in a survey or a census.) **A sampling error** can result even when no mistakes of any kind are made; sampling errors occur because no sample will ever perfectly match the data in the universe from which the sample is taken.

Company XYZ will also want to avoid non-sampling errors. **Non-sampling errors** are errors that result during data collection and cause the data to differ from the true values. Non-sampling errors are caused by human error, such as a mistake made in the survey process. If one group of consumers only watches five hours of video programming a week and is included in the survey, that decision is a non-sampling error. Asking questions that are biased is another type of error.

Why Is Sampling Error Important?

Being aware of the presence of sampling errors is important because it can be an indicator of the level of confidence that can be placed in the results. Sampling error is also important in the context of a discussion about how much research results can vary.

How Do You Find a Sampling Error?

In survey research, sampling errors occur because all samples are representative samples: a smaller group that stands in for the whole of your research population. It's impossible to survey

the entire group of people you'd like to reach. It's not usually possible to quantify the degree of sampling error in a study since it's impossible to collect the relevant data from the entire population you are studying. This is why researchers collect representative samples (and representative samples are the reason why there are sampling errors).

What Is Sampling Error and Sampling?

Sampling errors are statistical errors that arise when a sample does not represent the whole population. In statistics, sampling means selecting the group that you will actually collect data from in your research.

What Is the Sampling Error Formula?

$$\text{Sampling Error} = Z \times \frac{\sigma}{\sqrt{n}}$$

where:

Z = Z score value based on the
confidence interval (approx = 1.96)

σ = Population standard deviation

n = Size of the sample

The sampling error formula is used to calculate the overall sampling error in statistical analysis. The sampling error is calculated by dividing the standard deviation of the population by the square root of the size of the sample, and then multiplying the resultant with the Z score value, which is based on the confidence interval.

Lesson 19**METHODS OF QUANTITATIVE RESEARCH****Topic 019: Methods of Quantitative Research****Introduction**

Quantitative methods emphasize objective measurements and the statistical, mathematical, or numerical analysis of data collected through polls, questionnaires, and surveys, or by manipulating pre-existing statistical data using computational techniques. Quantitative research focuses on gathering numerical data and generalizing it across groups of people or to explain a particular phenomenon.

Quantitative research methods

Research method	How to use	Example
Experiment	Control or manipulate an independent variable to measure its effect on a dependent variable.	To test whether an intervention can reduce procrastination in college students, you give equal-sized groups either a procrastination intervention or a comparable task. You compare self-ratings of procrastination behaviors between the groups after the intervention.
Survey	Ask questions of a group of people in-person, over-the-phone or online.	You distribute questionnaires with rating scales to first-year international college students to investigate their experiences of culture shock.
(Systematic) observation	Identify a behavior or occurrence of interest and monitor it in its natural setting.	To study college classroom participation, you sit in on classes to observe them, counting and recording the prevalence of active and passive behaviors by students from different backgrounds.
Secondary research	Collect data that has been gathered for other purposes e.g., national surveys or historical records.	To assess whether attitudes towards climate change have changed since the 1980s, you collect relevant questionnaire data from widely available longitudinal studies.

CHART 1 Examples of Quantitative Studies

Study citation and title	Ridgeway and Erickson (2000), "Creating and Spreading Status Beliefs"	Musick, Wilson, and Bynum (2000), "Race and Formal Volunteering: The Differential Effects of Class and Religion"	Barlow, Barlow, and Chiricos (1995), "Economic Conditions and Ideologies of Crime in the Media"
Methodological technique used	Experiment	Survey	Content analysis
Topic	Processes by which people develop beliefs about the social status of others	Rates of volunteering by White and Black adults	U.S. mass media portrayals of law-breakers
Research question	As individuals interact, do external, structural factors that affect the interaction mold the beliefs they come to hold about entire categories of people in the future?	What different kinds of resources are available to Blacks and Whites that explain why Blacks are less likely to volunteer?	Do economic conditions affect how the media portray offenders?
Main hypothesis tested	People can be "taught" to make status distinctions among categories of people, who are actually equal, based on limited interaction in which one category exerts more skill.	Social class and religion affect whether Blacks volunteer differently than Whites.	The media distortion of crime shows offenders in a more negative way (blames them) when economic conditions are bad.
Main independent variable(s)	Whether a person's interaction with someone in a category that shows members of the category to have superior or inferior skill at tasks	Social class, religious attendance, race	Unemployment rate in several years, 1953–1982
Main dependent variable	Whether individuals develop and apply a belief of inequality to an entire category of people	Whether a person said he or she volunteered for any of five organizations (religious, education, political or labor, senior citizen, or local)	Whether distortion occurred, measured as a mismatch between media attention (articles in <i>Time</i> magazine) and crime statistics for several years
Unit of analysis	Individual undergraduate student	Individual adults	The media report
Universe	All individuals	All adult Whites and Blacks in the United States	All U.S. mass media reports

Strengths of Using Quantitative Methods

Quantitative researchers try to recognize and isolate specific variables contained within the study framework, seek correlation, relationships and causality, and attempt to control the environment in which the data is collected to avoid the risk of variables, other than the one being studied, accounting for the relationships identified. Among the specific strengths of using quantitative methods to study social science research problems:

- Allows for a broader study, involving a greater number of subjects, and enhancing the generalization of the results.
- Allows for greater objectivity and accuracy of results. Generally, quantitative methods are designed to provide summaries of data that support generalizations about the phenomenon under study. In order to accomplish this, quantitative research usually involves few variables and many cases, and employs prescribed procedures to ensure validity and reliability.
- Applying well established standards means that the research can be replicated, and then analyzed and compared with similar studies.
- You can summarize vast sources of information and make comparisons across categories and over time.

- Personal bias can be avoided by keeping a 'distance' from participating subjects and using accepted computational techniques.

Limitations of Using Quantitative Methods

Quantitative methods presume to have an objective approach to studying research problems, where data is controlled and measured, to address the accumulation of facts, and to determine the causes of behavior. As a consequence, the results of quantitative research may be statistically significant but are often humanly insignificant. Some specific limitations associated with using quantitative methods to study research problems in the social sciences include:

- Quantitative data is more efficient and able to test hypotheses, but may miss contextual detail.
- Uses a static and rigid approach and so employs an inflexible process of discovery.
- The development of standard questions by researchers can lead to "structural bias" and false representation, where the data actually reflects the view of the researcher instead of the participating subject.
- Results provide less detail on behavior, attitudes, and motivation.
- Researcher may collect a much narrower and sometimes superficial dataset.
- Results are limited as they provide numerical descriptions rather than detailed narrative and generally provide less elaborate accounts of human perception.
- The research is often carried out in an unnatural, artificial environment so that a level of control can be applied to the exercise. This level of control might not normally be in place in the real world thus yielding "laboratory results" as opposed to "real world results".
- Preset answers will not necessarily reflect how people really feel about a subject and, in some cases, might just be the closest match to the preconceived hypothesis.

References

Babbie, Earl R. (2010). *The Practice of Social Research*. 12th ed. Belmont, CA: Wadsworth Cengage, Muijs, Daniel. *Doing Quantitative Research in Education with SPSS*. 2nd edition. London: SAGE Publications.

Lesson 20**SURVEY RESEARCH****Topic 020: Survey Research****Introduction**

A survey is a systematic method for gathering information from (a sample of) entities for the purposes of constructing quantitative descriptors of the attributes of the larger population of which the entities are members. Surveys are conducted to gather information that reflects population's attitudes, behaviors, opinions and beliefs that cannot be observed directly. The success of survey research depends on how closely the answers that people give to survey questions match how people think and act in reality.

Reasons to conduct survey research

The most crucial and integral reason for conducting market research using surveys is that you can collect answers regarding specific, essential questions. You can ask these questions in multiple formats as per the target audience and the intent of the survey. Before designing a study, every organization must figure out the objective of carrying this out so that the study can be structured, planned, and executed to perfection.

Questions that need to be on your mind while designing a survey are:

- What is the primary aim of conducting the survey?
- How do you plan to utilize the collected survey data?
- What type of decisions you plan to take based on the points mentioned above.
- There are three critical reasons why an organization must conduct survey research.

Understand respondent behavior to get solutions to your queries: If you've carefully curated a survey, the respondents will provide insights about what they like about your organization as well as suggestions for improvement. To motivate them to respond, you must be very vocal about how secure their responses will be and how you will utilize the answers. This will push them to be 100% honest about their feedback, opinions, and comments. Online surveys or mobile surveys have proved their privacy, and due to this, more and more respondents feel free to put forth their feedback through these mediums.

Present a medium for discussion: A survey can be the perfect platform for respondents to provide criticism or applause for an organization. Important topics like product quality or quality of customer service etc. can be put on the table for discussion. A way you can do it is by including open-ended questions where the respondents can write their thoughts. This will make it easy for you to correlate your survey to what you intend to do with your product or service.

Strategy for never-ending improvements: An organization can establish the target audience's attributes from the pilot phase of survey research. Researchers can use the criticism and feedback received from this survey to improve the product/services. Once the company successfully makes the improvements, it can send out another survey to measure the change in feedback keeping the pilot phase the benchmark. By doing this activity, the organization can track what was effectively improved and what still needs improvement.

Table 8.2 Variables, Research Questions, and Items on a Survey

Variable Name	Research Question	Item on Survey
Independent Variable 1: Prior publications	Descriptive research Question 1: How many publications did the faculty member produce prior to receipt of the doctorate?	See Questions 11, 12, 13, 14, and 15: publication counts for journal articles, books, conference papers, book chapters published before receiving the doctorate
Dependent Variable 1: Grants funded	Descriptive research Question 2: How many grants has the faculty member received in the past 3 years?	See Questions 16, 17, and 18: grants from foundations, federal grants, state grants
Control Variable 1: Tenure status	Descriptive research Question 3: Is the faculty member tenured?	See Question 19: tenured (yes/no)
Relating the Independent Variable 1: Prior publications to the Dependent Variable: Grants funded	Inferential Question 4: Does prior productivity influence the number of grants received?	See Questions 11,12,13,14,15 to Questions 16, 17, 18

Characteristics of Survey

Kraemer (1991) identified three distinguishing characteristics of survey research (p. xiii).

- Survey research is used to quantitatively describe specific aspects of a given population. These aspects often involve examining the relationships among variables.
- The data required for survey research are collected from people and are, therefore, subjective.
- Survey research uses a selected portion of the population from which the findings can later be generalized back to the population.

BASIC SURVEY DESIGNS

Cross-Sectional Surveys: Data are collected at one point in time from a sample selected to represent a larger population.

Longitudinal Surveys: Data are collected at multiple point in time from a sample selected to represent a larger population.

Trend: Surveys of sample population at different points in time

Cohort: Study of same population each time data are collected, although samples studied may be different

Panel: Collection of data at various time points with the same sample of respondents.

Benefits of survey research

In case survey research is used for all the right purposes and is implemented properly, marketers can benefit by gaining useful, trustworthy data that they can use to better the ROI of the organization. Other benefits of survey research are:

- **Minimum investment:** Mobile surveys and online surveys have minimal finance invested per respondent. Even with the gifts and other incentives provided to the people who participate in the study, online surveys are extremely economical compared to the paper-based surveys.
- **Versatile sources for response collection:** You can conduct surveys via various mediums like online and mobile surveys. You can further classify them into qualitative mediums like focus groups, interviews, and quantitative mediums like customer-centric surveys. Due to the offline survey response collection option, researchers can conduct surveys in remote areas with limited internet connectivity. This can make data collection and analysis more convenient and extensive.

- **Reliable for respondents:** Surveys are extremely secure as the respondent details and responses are kept safeguarded. This anonymity makes respondents answer the survey questions candidly and with absolute honesty. An organization seeking to receive explicit responses for its survey research must mention that it will be confidential.

Weakness of Survey

- Surveys are generally unsuitable where an understanding of the historical context of phenomena is required.
- Biases may occur in Survey research, either in the lack of response from intended participants or in the nature and accuracy of the responses that are received.
- Other sources of error include intentional misreporting of behaviors by respondents to confound the survey results or to hide inappropriate behavior.
- Respondents may have difficulty assessing their own behavior or have poor recall of the circumstances surrounding their behavior.

What is Asked in a Survey?

Although the categories overlap, the following can be asked in a survey:

1. **Behavior:** How frequently do you brush your teeth? Did you vote in the last city election? When did you last visit a close relative?
2. **Attitudes/beliefs/opinions:** What type of job do you think the mayor is doing? Do you think other people say many negative things about you when you are not there? What is the biggest problem facing the nation these days?
3. **Characteristics:** Are you married, never married, single, divorced, separated, or widowed? Do you belong to a union? What is your age?
4. **Expectations:** Do you plan to buy a new car in the next 12 months? How much schooling do you think your child will get? Do you think the population in this town will grow, decrease, or stay the same?
5. **Self-classification:** Do you consider yourself to be liberal, moderate, or conservative? Into which social class would you put your family? Would you say you are highly religious or not religious?
6. **Knowledge:** Who was elected mayor in the last election? About what percentage of the people in this city are non-White? Is it legal to own a personal copy of Karl Marx's Communist Manifesto in this country?

Table 8.1 A Checklist of Questions for Designing a Survey Method

	Is the purpose of a survey design stated?
	Are the reasons for choosing the design mentioned?
	Is the nature of the survey (cross-sectional vs. longitudinal) identified?
	Is the population and its size mentioned?
	Will the population be stratified? If so, how?
	How many people will be in the sample? On what basis was this size chosen?
	What will be the procedure for sampling these individuals (e.g., random, nonrandom)?
	What instrument will be used in the survey? Who developed the instrument?
	What are the content areas addressed in the survey? The scales?
	What procedure will be used to pilot or field-test the survey?
	What is the timeline for administering the survey?
	What are the variables in the study?
	How do these variables cross-reference with the research questions and items on the survey?
	What specific steps will be taken in data analysis to do the following:
(a)	Analyze returns?
(b)	Check for response bias?
(c)	Conduct a descriptive analysis?
(d)	Collapse items into scales?
(e)	Check for reliability of scales?
(f)	Run inferential statistics to answer the research questions or assess practical implications of the results?
	How will the results be interpreted?

Steps in Conducting a Survey

The survey researcher follows a deductive approach. He or she begins with a theoretical or applied research problem and ends with empirical measurement and data analysis. Once a researcher decides that survey is an appropriate method, basic steps in a research project can broadly be divided into six sub-steps.

1. Develop the hypothesis

Decide on type of survey (mail, interview, telephone); write survey questions (decide on response categories, design lay out). The researcher develops an instrument – a survey questionnaire or interview schedule – that he or she uses to measure variables. Respondents read the questions themselves and mark answers on a questionnaire. An interview schedule is a set of questions read to the respondent by an interviewer, who also records the responses. To simplify the discussion, we will use only the term questionnaire.

2. Plan how to record data

Pilot test survey instrument. When preparing the questionnaire, the researcher thinks ahead to how he or she will record and organize data for analysis. The questionnaire is pilot tested on a small set of respondents similar to those in the final survey.

3. Decide on target population

Get sampling frame; decide on sample size; select the sample.

4. Locate respondents

Conduct interviews; carefully record data. The researcher locates sampled respondents in person, by telephone, or by mail. Respondents are given information and instructions on completing the questionnaire or interview.

5. Enter data into computers

Recheck all data; perform statistical analysis on data.

6. Describe methods and findings in research report

Present findings to others for critique and evaluation.

Tips To Design the Perfect Research Survey

- **Set your SMART goals:** Before conducting any market research or creating a particular plan, set your SMART Goals. What is that you want to achieve with the survey? How will you measure it promptly, and what are the results you are expecting?
- **Choose the right questions:** Designing a survey can be a tricky task. Asking the right questions may help you get the answers you are looking for and ease the task of analyzing. So, always choose those specific questions – relevant to your research.
- **Begin your survey with a generalized question:** Preferably, start your survey with a General Question to understand whether the respondent uses the product or not. That also provides an excellent base and intro for your survey.
- **Enhance your survey:** Choose the best, most relevant, 15-20 questions. Frame each question as a different question type, based on the kind of answer you would like to gather from each. Create a survey using different types of questions such as multiple-choice, rating scale, open-ended, etc. Look at more survey examples and four measurement scales every researcher should remember.
- **Prepare yes/no questions:** You may also want to use yes/no questions to separate people or branch them into groups of those who “have purchased” and those who “have not yet purchased” your products or services. Once you separate them, you can ask them different questions.
- **Test all electronic devices:** It becomes effortless to distribute your surveys if respondents can answer them on different electronic devices like mobiles, tablets, etc. Once you have created your survey, it's time to TEST. You can also make any corrections if needed at this stage.
- **Distribute your survey:** Once your survey is ready, it is time to share and distribute to the right audience. You can share handouts and share them via email, social media, and other industry-related offline/online communities.
- **Collect and analyze responses:** After distributing your survey, it is time to gather all responses. Make sure you store your results in a particular document or an excel sheet, with all the necessary categories mentioned, so that you don't lose your data. Remember, this is the most crucial stage. Segregate your responses based on demographics, psychographics, and behavior. This is because, as a researcher, you must know where your responses are coming from. It will help you to analyze, predict decisions, and help write the summary report.
- **Prepare your summary report:** Now, is the time to share your analysis. At this stage, you should mention all the responses gathered from a survey in a fixed format. Also, the reader/customer must get clarity about your goal, which you were trying to gain from the study. Questions such as – whether the product or service has been used/preferred or not. Do respondents prefer some other product to another? Any recommendations?

Lesson 21QUANTITATIVE CONTENT ANALYSISTopic 021: Quantitative Content Analysis**Introduction**

Content analysis refers to a family of procedures for the systematic, replicable analysis of text. In essence it involves the classification of parts of a text through the application of a structured, systematic coding scheme from which conclusions can be drawn about the message content. By clearly specifying the coding and other procedures content analysis is replicable in the sense that other researchers could reproduce the study. Content analysis can be carried out quantitatively but also qualitatively. In this technical supplement we focus on quantitative content analysis; qualitative content analysis is discussed in the technical supplement on qualitative approaches to language analysis. Content analysis can be applied to all kinds of written text such as speeches, letters or articles whether digital or in print, as well as text in the form of pictures, video, film or other visual media.

It can be used to examine both the manifest and the latent content of a text. **Manifest content** refers to the visible, countable components of the message. **Latent content** refers to the meaning that may lie behind the manifest content. Manifest content in the form of images of women in advertisements engaged in activities such as domestic work or child care, for example, might be taken as indicators of gender stereotyping, a latent concept. Both manifest Content analysis can also be used to investigate both substantive (content) and form (or formal) features of a text. Substantive features refer to what is being said in the message. Form features refer to how it is being said (Schreier 2012). A content analysis of advertisements, for instance, might distinguish between the way in which the benefits of a product are described (substantive features) and the way in which the advertisement makes use of headings, different font sizes, the placement of graphics and so on (form features).

Types of Content Analysis

Content analysis can be both quantitative (focused on counting and measuring) and qualitative (focused on interpreting and understanding). In both types, you categorize or “code” words, themes, and concepts within the texts and then analyze the results.

1. Quantitative content analysis example

To research the importance of employment issues in political campaigns, you could analyze campaign speeches for the frequency of terms such as *unemployment*, *jobs*, and *work* and use statistical analysis to find differences over time or between candidates.

2. Qualitative content analysis example

To gain a more qualitative understanding of employment issues in political campaigns, you could locate the word *unemployment* in speeches, identify what other words or phrases appear next to it (such as *economy*, *inequality* or *laziness*), and analyze the meanings of these relationships to better understand the intentions and targets of different campaigns

Applications of content analysis

Content analysis provides a structured way of analysing data that are typically open-ended and relatively unstructured. Two important aims of such analysis for business and management research are:

• Description

Here the focus is on describing features of the message content. Jain et al. (2010), for example, study how the ways in which celebrities were presented in Indian television commercials varied according to the category of products they were promoting. Descriptive content analysis can be cross-sectional or longitudinal. An example of the latter is Paek et al.'s (2012) investigation of the promotion techniques used in cigarette advertising over a fifty-year period.

• Prediction

Here the main aim is to predict the outcome or effect of the messages being analysed. Through the measurement of relevant features of the message, the researcher seeks to predict audience or receiver reaction (Neuendorf 2002). A study by Naccarato and Neuendorf (1998), for example, investigates how different features of print media advertising affected recall, readership and evaluation in a business-tobusiness context. In that particular study, content analysis of the advertisements is combined with survey data to allow the researchers to assess the effect of particular features of the advertising. Content analysis has been applied to a wide range of social science topics including gender and race, violence, media reporting and political communication. Insch et al. (1997) suggest its use is less common in organisational research due to lack of familiarity with the method. Nevertheless it has obvious applications in the analysis of business communication, particularly marketing. The rise of the analysis techniques to analyse online communication. Examples include Jose and Lee's (2007) study of global corporations' environmental reporting based on examination of their websites and Gebauer et al.'s (2008) analysis of online user reviews to identify requirements for mobile technology.

Quantitative Content Analysis

Quantitative content analysis, "the systematic, objective, quantitative analysis of message characteristics" (Neuendorf, 2002, p. 1)

Key Steps In Quantitative Content Analysis

1. Select the content you will analyze

Based on your research question, choose the texts that you will analyze. You need to decide:

- The medium (e.g. newspapers, speeches or websites) and genre (e.g. opinion pieces, political campaign speeches, or marketing copy)
- The criteria for inclusion (e.g. newspaper articles that mention a particular event, speeches by a certain politician, or websites selling a specific type of product)
- The parameters in terms of date range, location, etc.

If there are only a small amount of texts that meet your criteria, you might analyze all of them. If there is a large volume of texts, you can select a sample.

For Example we select a topic to research media representations of younger and older politicians, you decide to analyze news articles and opinion pieces in print newspapers between 2017–2019. Because this is a very large volume of content, you choose three major national newspapers and sample only Monday and Friday editions.

2. Define the units and categories of analysis

Next, you need to determine the level at which you will analyze your chosen texts. This means defining:

- The **unit(s) of meaning** that will be coded. For example, are you going to record the frequency of individual words and phrases, the characteristics of people who produced or

appear in the texts, the presence and positioning of images, or the treatment of themes and concepts?

- The **set of categories** that you will use for coding. Categories can be objective characteristics (e.g. *aged 30-40, lawyer, parent*) or more conceptual (e.g. *trustworthy, corrupt, conservative, family oriented*).

Your units of analysis are the politicians who appear in each article and the words and phrases that are used to describe them. Based on your research question, you have to categorize based on age and the concept of trustworthiness. To get more detailed data, you also code for other categories such as their political party and the marital status of each politician mentioned.

3. Develop a set of rules for coding

Coding involves organizing the units of meaning into the previously defined categories. Especially with more conceptual categories, it's important to clearly define the rules for what will and won't be included to ensure that all texts are coded consistently.

Coding rules are especially important if multiple researchers are involved, but even if you're coding all of the text by yourself, recording the rules makes your method more transparent and reliable.

In considering the category "younger politician," you decide which titles will be coded with this category (*senator, governor, counselor, mayor*). With "trustworthy", you decide which specific words or phrases related to trustworthiness (e.g. *honest* and *reliable*) will be coded in this category.

4. Code the text according to the rules

You go through each text and record all relevant data in the appropriate categories. This can be done manually or aided with computer programs, such as QSR NVivo, Atlas.ti and Diction, which can help speed up the process of counting and categorizing words and phrases.

Following your coding rules, you examine each newspaper article in your sample. You record the characteristics of each politician mentioned, along with all words and phrases related to trustworthiness that are used to describe them.

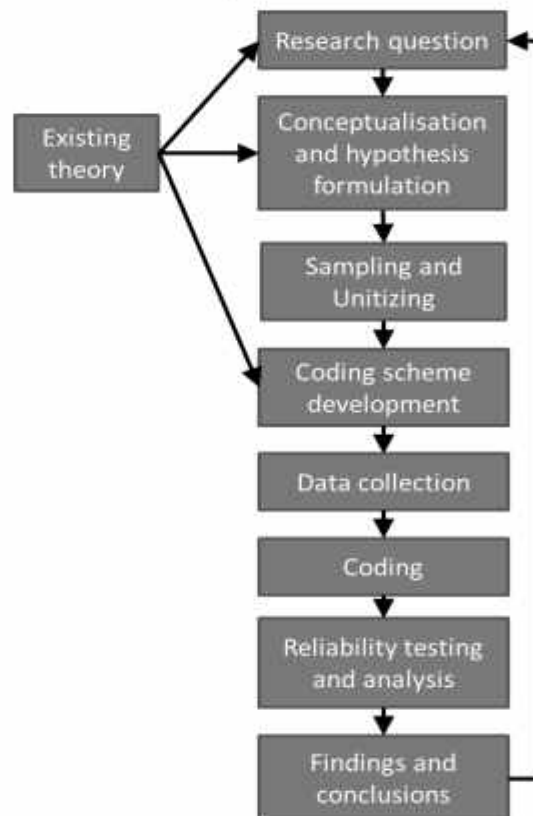
5. Analyze the results and draw conclusions

Once coding is complete, the collected data is examined to find patterns and draw conclusions in response to your research question. You might use statistical analysis to find correlations or trends, discuss your interpretations of what the results mean, and make inferences about the creators, context and audience of the texts.

Let's say the results reveal that words and phrases related to trustworthiness appeared in the same sentence as an older politician more frequently than they did in the same sentence as a younger politician. From these results, you conclude that national newspapers present older politicians as more trustworthy than younger politicians, and infer that this might have an effect on readers' perceptions of younger people in politics.

The following figure outlines the key stages in a quantitative content analysis project.

Figure 1 – Key steps in quantitative content analysis



Examples

Research in practice 1 – Example code book (adapted from Zhang et al. 2009)

Example code book from a study comparing gender role portrayals in magazine advertising

1. Gender of the central figure (male 0; female 1)
2. Age of the central figure (young adult (18–34 years of age) 1; mid adult (35–50 years of age) 2; older adult (over 50 years of age) 3; indeterminate 4)
3. Occupational/non-occupational role of the central figure (occupational 0; non-occupational 1; indeterminate 2)
4. Subdivision of occupational role of the central figure (high-level executive 1; professional 2; entertainer/media 3; professional sports 4; mid-level business/semi-professional 5; non-professional/white collar 6; non-professional blue-collar 7; indeterminate 8)
5. Subdivision of non-occupational role of the central figure (family 1; recreational 2; decorative 3)
6. Credibility of the central figures (product user or presenter 1; product authority 2; decorative 3; indeterminate 4)

Shaken and stirred: portrayals of women in James Bond films

How women are portrayed in the media has long been a subject of interest to researchers. Neuendorf et al.'s (2010) study uses quantitative content analysis to investigate how women are depicted in the long-running and very popular series of James Bond films. Three research questions are linked to how the portrayal of women has changed over time with respect to 1) their physical characteristics 2) their level of sexual activity 3) the amount and level of violence directed against them. Three further questions analyse whether the way that a female character is portrayed (in terms, for instance, of her physical characteristics) predicts 1) the amount of sexual activity in which she is involved 2) the amount of aggression directed at her 3) whether the character survives the film. The coding unit is female characters who meet certain criteria (e.g. they speak or are spoken to). The code book defines a range of variables to be measured for each character, such as race, hair colour, body size, physical attractiveness, along with variables measuring aspects of sexual activity and violence by and against the character. Eight coders were used to code the 20 films. Inter-coder reliability was tested using one of the twenty films and the results are reported in the study. Research findings showed some minor changes over time in terms of more female roles, more sexual activity and greater likelihood of being

Lesson 22**EXPERIMENTAL RESEARCH****Topic 022: Experimental Research****Experimental Research**

Experimental research is a scientific approach to research, where one or more independent variables are manipulated and applied to one or more dependent variables to measure their effect on the latter. The effect of the independent variables on the dependent variables is usually observed and recorded over some time, to aid researchers in drawing a reasonable conclusion regarding the relationship between these 2 variable types. The experimental research method is widely used in physical and social sciences, psychology, and education. It is based on the comparison between two or more groups with a straightforward logic, which may, however, be difficult to execute. Mostly related to a laboratory test procedure, experimental research designs involve collecting quantitative data and performing statistical analysis on them during research. Therefore, making it an example of quantitative research method.

Examples of Experimental Research

Experimental research examples are different, depending on the type of experimental research design that is being considered. The most basic example of experimental research is laboratory experiments, which may differ in nature depending on the subject of research.

Administering Exams After The End of Semester

During the semester, students in a class are lectured on particular courses and an exam is administered at the end of the semester. In this case, the students are the subjects or dependent variables while the lectures are the independent variables treated on the subjects.

Only one group of carefully selected subjects are considered in this research, making it a pre-experimental research design example. We will also notice that tests are only carried out at the end of the semester, and not at the beginning. Further making it easy for us to conclude that it is a one-shot case study research.

Employee Skill Evaluation

Before employing a job seeker, organizations conduct tests that are used to screen out less qualified candidates from the pool of qualified applicants. This way, organizations can determine an employee's skill set at the point of employment. In the course of employment, organizations also carry out employee training to improve employee productivity and generally grow the organization. Further evaluation is carried out at the end of each training to test the impact of the training on employee skills, and test for improvement. Here, the subject is the employee, while the treatment is the training conducted. This is a pretest-posttest control group experimental research example.

Evaluation of Teaching Method

Let us consider an academic institution that wants to evaluate the teaching method of 2 teachers to determine which is best. Imagine a case whereby the students assigned to each teacher is carefully selected probably due to personal request by parents or due to stubbornness and smartness. This is a no equivalent group design example because the samples are not equal. By evaluating the effectiveness of each teacher's teaching method this way, we may conclude after a post-test has been carried out. However, this may be influenced by factors like the natural sweetness of a student. For example, a very smart student will grab more easily than his or her peers irrespective of the method of teaching.

Characteristics of Experimental Research

- **Variables**

Experimental research contains dependent, independent and extraneous variables. The dependent variables are the variables being treated or manipulated and are sometimes called the subject of the research.

The independent variables are the experimental treatment being exerted on the dependent variables. Extraneous variables, on the other hand, are other factors affecting the experiment that may also contribute to the change.

- **Setting**

The setting is where the experiment is carried out. Many experiments are carried out in the laboratory, where control can be exerted on the extraneous variables, thereby eliminating them.

Other experiments are carried out in a less controllable setting. The choice of setting used in research depends on the nature of the experiment being carried out.

- **Multivariable**

Experimental research may include multiple independent variables, e.g. time, skills, test scores, etc.

Why Use Experimental Research Design?

Experimental research design can be majorly used in physical sciences, social sciences, education, and psychology. It is used to make predictions and draw conclusions on a subject matter. Some uses of experimental research design are highlighted below.

- **Medicine:** Experimental research is used to provide the proper treatment for diseases. In most cases, rather than directly using patients as the research subject, researchers take a sample of the bacteria from the patient's body and are treated with the developed antibacterial

The changes observed during this period are recorded and evaluated to determine its effectiveness. This process can be carried out using different experimental research methods.

- **Education:** Asides from science subjects like Chemistry and Physics which involves teaching students how to perform experimental research, it can also be used in improving the standard of an academic institution. This includes testing students' knowledge on different topics, coming up with better teaching methods, and the implementation of other programs that will aid student learning.
- **Human Behavior:** Social scientists are the ones who mostly use experimental research to test human behaviour. For example, consider 2 people randomly chosen to be the subject of the social interaction research where one person is placed in a room without human interaction for 1 year. The other person is placed in a room with a few other people, enjoying human interaction. There will be a difference in their behaviour at the end of the experiment.
- **UI/UX:** During the product development phase, one of the major aims of the product team is to create a great user experience with the product. Therefore, before launching the final product design, potential are brought in to interact with the product. For example, when finding it difficult to choose how to position a button or feature on the app interface, a random sample of product testers are allowed to test the 2 samples and how the button positioning influences the user interaction is recorded.

Advantages of Experimental Research

It's vital to test new ideas or theories. Why put time, effort, and funding into something that may not work? Experimental research allows you to test your idea in a controlled environment before taking it to market. It also provides the best method to test your theory, thanks to the following advantages:

- Researchers have a stronger hold over variables to obtain desired results.
- The subject or industry does not impact the effectiveness of experimental research. Any industry can implement it for research purposes.
- The results are specific.
- After analyzing the results, you can apply your findings to similar ideas or situations.
- You can identify the cause and effect of a hypothesis. Researchers can further analyze this relationship to determine more in-depth ideas.
- Experimental research makes an ideal starting point. The data you collect is a foundation on which to build more ideas and conduct more research.

Whether you want to know how the public will react to a new product or if a certain food increases the chance of disease, experimental research is the best place to start.

Advantages of experimental research

1 Researchers have a stronger hold over variables to obtain desired results.



2 The subject or industry does not impact the effectiveness of experimental research. Any industry can implement it for research purposes.



3 The results are specific.



4 After analyzing the results, you can apply your findings to similar ideas or situations.



5 You can identify the cause and effect of a hypothesis. Researchers can further analyze this relationship to determine more in-depth ideas.



6 The data you collect is a foundation on which to build more ideas and conduct more research.



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Disadvantages of Experimental Research

- It is highly prone to human error due to its dependency on variable control which may not be properly implemented. These errors could eliminate the validity of the experiment and the research being conducted.
- Exerting control of extraneous variables may create unrealistic situations. Eliminating real-life variables will result in inaccurate conclusions. This may also result in researchers controlling the variables to suit his or her personal preferences.
- It is a time-consuming process. So much time is spent on testing dependent variables and waiting for the effect of the manipulation of dependent variables to manifest.
- It is expensive.
- It is very risky and may have ethical complications that cannot be ignored. This is common in medical research, where failed trials may lead to a patient's death or a deteriorating health condition.
- Experimental research results are not descriptive.
- Response bias can also be supplied by the subject of the conversation.
- Human responses in experimental research can be difficult to measure.

What are the Data Collection Methods in Experimental Research?

Data collection methods in experimental research are the different ways in which data can be collected for experimental research. They are used in different cases, depending on the type of research being carried out.

1. Observational Study

This type of study is carried out over a long period. It measures and observes the variables of interest without changing existing conditions. When researching the effect of social interaction on human behavior, the subjects who are placed in 2 different environments are observed throughout the research. No matter the kind of absurd behavior that is exhibited by the subject during this period, its condition will not be changed. This may be a very risky thing to do in medical cases because it may lead to death or worse medical conditions.

2. Simulations

This procedure uses mathematical, physical, or computer models to replicate a real-life process or situation. It is frequently used when the actual situation is too expensive, dangerous, or impractical to replicate in real life. This method is commonly used in engineering and operational research for learning purposes and sometimes as a tool to estimate possible outcomes of real research. Some common situation software are Simulink, MATLAB, and Simul8. Not all kinds of experimental research can be carried out using simulation as a data collection tool. It is very impractical for a lot of laboratory-based research that involves chemical processes.

3. Surveys

A survey is a tool used to gather relevant data about the characteristics of a population and is one of the most common data collection tools. A survey consists of a group of questions prepared by the researcher, to be answered by the research subject. Surveys can be shared with the respondents both physically and electronically. When collecting data through surveys, the kind of data collected depends on the respondent, and researchers have limited control over it. Form plus is the best tool for collecting experimental data using surveys. It has relevant features

that will aid the data collection process and can also be used in other aspects of experimental research.

Differences between Experimental and Non-Experimental Research

1. In experimental research, the researcher can control and manipulate the environment of the research, including the predictor variable which can be changed. On the other hand, non-experimental research cannot be controlled or manipulated by the researcher at will.

This is because it takes place in a real-life setting, where extraneous variables cannot be eliminated. Therefore, it is more difficult to conclude non-experimental studies, even though they are much more flexible and allow for a greater range of study fields.

2. The relationship between cause and effect cannot be established in non-experimental research, while it can be established in experimental research. This may be because many extraneous variables also influence the changes in the research subject, making it difficult to point at a particular variable as the cause of a particular change

3. Independent variables are not introduced, withdrawn, or manipulated in non-experimental designs, but the same may not be said about experimental research.

Table 8.4 A Checklist of Questions for Designing an Experimental Procedure

	Who are the participants in the study?
	What is the population to which the results of the participants will be generalized?
	How were the participants selected? Was a random selection method used?
	How will the participants be randomly assigned? Will they be matched? How?
	How many participants will be in the experimental and control group(s)?
	What is the dependent variable or variables (i.e., outcome variable) in the study? How will it be measured? Will it be measured before and after the experiment?
	What is the treatment condition(s)? How was it operationalized?
	Will variables be covaried in the experiment? How will they be measured?
	What experimental research design will be used? What would a visual model of this design look like?
	What instrument(s) will be used to measure the outcome in the study? Why was it chosen? Who developed it? Does it have established validity and reliability? Has permission been sought to use it?
	What are the steps in the procedure (e.g., random assignment of participants to groups, collection of demographic information, administration of pretest, administration of treatment(s), administration of posttest)?
	What are potential threats to internal and external validity for the experimental design and procedure? How will they be addressed?
	Will a pilot test of the experiment be conducted?
	What statistics will be used to analyze the data (e.g., descriptive and inferential)?
	How will the results be interpreted?

Lesson 23**QUANTITATIVE MEASUREMENTS AND SCALING****Topic 023: Quantitative Measurements and Scaling****Introduction**

The level of measurement refers to the relationship among the values that are assigned to the attributes for a variable. A system for organizing information in the measurement of variables into four levels, from nominal level to ratio level (Neumann, 2014).

How we determined Level of Measurement

The level of measurement is determined by how refined, exact, and precise a construct is in our assumptions about it. This means that how we conceptualize a construct carries serious implications. It influences how we can measure the construct and restricts the range of statistical procedures that we can use after we have gathered data. Often we see a trade-off between the level of measurement and the ease of measuring. Measuring at a low level is simpler and easier than it is at a high level; however, a low level of measurement offers us the least refined information and allows the fewest statistical procedures during data analysis.

Issues of Level of Measurement

We can look at the issue in two ways:

- (1) Continuous versus discrete variable
- (2) The four levels of measurement.

1) Continuous and Discrete Variables

Variables can be continuous or discrete. **Continuous variables** contain a large number of values or attributes that flow along a continuum. We can divide a continuous variable into many smaller increments; in mathematical theory, the number of increments is infinite. Examples of continuous variables include temperature, age, income, crime rate, and amount of schooling. For example, we can measure the amount of your schooling as the years of schooling you completed. We can subdivide this into the total number of hours you have spent in classroom instruction and out-of-class assignments or preparation. We could further refine this into the number of minutes you devoted to acquiring and processing information and knowledge in school or due to school assignments. We could further refine this into all of the seconds that your brain was engaged in specific cognitive activities as you were acquiring and processing information. **Discrete variables** have a relatively fixed set of separate values or variable attributes. Instead of a smooth continuum of numerous values, discrete variables contain a limited number of distinct categories. Examples of discrete variables include gender (male or female), religion (Protestant, Catholic, Jew, Muslim, atheist), marital status (never married single, married, divorced or separated, widowed), or academic degrees (high school diploma, or community college associate, four-year college, master's or doctoral degrees). Whether a variable is continuous or discrete affects its level of measurement.

Four Levels of Measurement

Levels of measurement build on the difference between continuous and discrete variables. Higher level measures are continuous and lower level ones are discrete. The four levels of measurement categorize its precision. Deciding on the appropriate level of measurement for a construct is not always easy. It depends on two things: how we understand a construct (its definition and assumptions), and the type of indicator or measurement procedure. The way we conceptualize a construct can limit how precisely we can measure it. For example, we might

reconceptualize some of the variables listed earlier as continuous to be discrete. We can think of temperature as a continuous variable with thousands of refined distinctions (e.g., degrees and fractions of degrees). Alternatively, we can think of it more crudely as five discrete categories (e.g., very hot, hot, cool, cold, very cold). We can think of age as continuous (in years, months, days, hours, minutes, or seconds) or discrete categories (infancy, childhood, adolescence, young adulthood, middle age, old age). While we can convert continuous variables into discrete ones, we cannot go the other way around, that is, convert discrete variables into continuous ones. For example, we cannot turn sex, religion, and marital status into continuous variables. We can, however, treat related constructs with slightly different definitions and assumptions as being continuous (e.g., amount of masculinity or femininity, degree of religiousness, commitment to a marital relationship). There is a practical reason to conceptualize and measure at higher levels of measurement: We can collapse higher levels of measurement to lower levels, but the reverse is not true. There are 4 levels of measurement:

- **Nominal:** The lowest, least precise level of measurement for which there is a difference in type only among the categories of a variable. The data can only be categorized
- **Ordinal:** A level of measurement that identifies a difference among categories of a variable and allows the categories to be rank ordered as well. The data can be categorized and ranked
- **Interval:** A level of measurement that identifies differences among variable attributes, ranks categories, and measures distance between categories but has no true zero. The data can be categorized, ranked, and evenly spaced
- **Ratio:** The highest, most precise level of measurement; variable attributes can be rank ordered, the distance between them precisely measured, and there is an absolute zero. The data can be categorized, ranked, evenly spaced, and has a natural zero.

Example of Four Levels of Measurement

VARIABLE (LEVEL OF MEASUREMENT)	HOW VARIABLE IS MEASURED
Religion (nominal)	Different religious denominations (Jewish, Catholic, Lutheran, Baptist) are not ranked but are only different (unless one belief is conceptualized as closer to heaven).
Attendance (ordinal)	"How often do you attend religious services? (0) Never, (1) less than once a year, (3) several times a year, (4) about once a month, (5) two or three times a week, or (8) several times a week." This might have been measured at a ratio level if the exact number of times a person attended were asked instead.
IQ score (interval)	Most intelligence tests are organized with 100 as average, middle, or normal. Scores higher or lower indicate distance from the average. Someone with a score of 115 has somewhat above average measured intelligence for people who took the test, whereas 90 is slightly below. Scores of below 65 or above 140 are rare.
Age (ratio)	Age is measured by years. There is a true zero (birth). Note that a 40-year-old has lived twice as long as a 20-year-old.

Distinguishing among the Four Levels

The four levels from lowest to highest precision are nominal, ordinal, interval, and ratio. Each level provides a different type of information. **Nominal-level** measurement indicates that a difference exists among categories (e.g., religion: Protestant, Catholic, Jew, Muslim; racial heritage: African, Asian, Caucasian, Hispanic, other). **Ordinal-level** measurement indicates a difference and allows us to rank order the categories (e.g., letter grades: A, B, C, D, F; opinion measures: strongly agree, agree, disagree, strongly disagree). **Interval-level** measurement does

everything the first two do and allows us to specify the amount of distance between categories (e.g., Fahrenheit or Celsius temperature: 5°, 45°, 90°; IQ scores: 95, 110, 125). **Ratio-level** measurement does everything the other levels do, and it has a true zero. This feature makes it possible to state relationships in terms of proportion or ratios (e.g., money income: \$10, \$100, \$500; years of formal schooling: 1, 10, 13). In most practical situations, the distinction between interval and ratio levels makes little difference.

TABLE 2 Characteristics of the Four Levels of Measurements

LEVEL	DIFFERENT CATEGORIES	RANKED	DISTANCE BETWEEN CATEGORIES MEASURED	TRUE ZERO
Nominal	Yes			
Ordinal	Yes	Yes		
Interval	Yes	Yes	Yes	
Ratio	Yes	Yes	Yes	Yes

Nominal level	Examples of nominal scales
You can categorize your data by labelling them in mutually exclusive groups, but there is no order between the categories.	• City of birth • Gender • Ethnicity • Car brands • Marital status
Ordinal level	Examples of ordinal scales
You can categorize and rank your data in an order, but you cannot say anything about the intervals between the rankings. Although you can rank the top 5 Olympic medallists, this scale does not tell you how close or far apart they are in number of wins.	• Top 5 Olympic medallists • Language ability (e.g., beginner, intermediate, fluent) • Likert-type questions (e.g., very dissatisfied to very satisfied)
Interval level	Examples of interval scales
You can categorize, rank, and infer equal intervals between neighboring data points, but there is no true zero point. The difference between any two adjacent temperatures is the same: one degree. But zero degrees is defined differently depending on the scale – it doesn't mean an absolute absence of temperature. The same is true for test scores and personality inventories. A zero on a test is arbitrary; it does not mean that the test-taker has an absolute lack of the trait being measured.	• Test scores (e.g., IQ or exams) • Personality inventories • Temperature in Fahrenheit or Celsius

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Ratio level	Examples of ratio scales
You can categorize , rank , and infer equal intervals between neighboring data points, and there is a true zero point.	• Height • Age • Weight • Temperature in Kelvin
A true zero means there is an absence of the variable of interest. In ratio scales, zero does mean an absolute lack of the variable.	
For example, in the Kelvin temperature scale, there are no negative degrees of temperature – zero means an absolute lack of thermal energy.	

Why is Level of Measurement Important?

First, knowing the level of measurement helps you decide how to interpret the data from that variable. When you know that a measure is nominal (like the one just described), then you know that the numerical values are just short codes for the longer names. Second, knowing the level of measurement helps you decide what statistical analysis is appropriate on the values that were assigned. If a measure is nominal, then you know that you would never average the data values or do a t-test on the data.

Principles of Good Measurement

Three features of good measurement whether we are considering using a single-indicator or a scale or index (discussed next) to measure a variable are that (1) the attributes or categories of a variable should be mutually exclusive, (2) they should also be exhaustive, and (3) the measurement should be unidimensional.

1. Mutually exclusive attributes means that an individual or a case will go into one and only one variable category. For example, we wish to measure the variable type of religion using the four attributes Christian, non-Christian, Jewish, and Muslim. Our measure is not mutually exclusive. Both Islam and Judaism are non-Christian religious faiths. A Jewish person and a Muslim fit into two categories: (1) the non-Christian and (2) Jewish or Muslim. Another example without mutually exclusive attributes is to measure the type of city using the three categories of river port city, state capital, and access to an international airport. A city could be all three (a river port state capital with an international airport), any combination of the three, or none of the three. To have mutually exclusive attitudes, we must create categories so that cases cannot be placed into more than one category.

2. Exhaustive attribute means that every case has a place to go or fits into at least one of a variable's categories. Returning to the example of the variable religion, with the four categorical attributes of Christian, non-Christian, Jewish, and Muslim, say we drop the non-Christian category to make the attributes mutually exclusive: Christian, Jewish, or Muslim. These are not exclusive attributes. The Buddhist, Hindu, atheist, and agnostic do not fit anywhere. We must create attributes to cover every possible situation. For example, Christian, Jewish, Muslim, or Other attributes for religion would be exclusive and mutually exclusive.

3. Unidimensionality means that a measure fits together or measures one single, coherent construct. Unidimensionality states that if we combine several specific pieces of information into a single score or measure, all of the pieces should measure the same thing. We sometimes use a more advanced technique—factor analysis—to test for the unidimensionality of data.

We may see an apparent contradiction between the idea of using multiple indicators or a scale or index to capture diverse parts of a complex construct and the criteria of unidimensionality. The contradiction is apparent only because constructs vary theoretically by level of abstraction. We may define a complex, abstract construct using multiple subdimensions, each being a part of the complex construct's overall content. In contrast, simple, low-level constructs that are concrete typically have just one dimension. For example, "feminist ideology" is a highly abstract and complex construct. It includes specific beliefs and attitudes toward social, economic, political, family, and sexual relations. The ideology's belief areas are parts of the single, more abstract and general construct. The parts fit together as a whole. They are mutually reinforcing and collectively form one set of beliefs about the dignity, strength, and power of women. To create a unidimensional measure of feminist ideology requires us to conceptualize it as a unified belief system that might vary from very antifeminist to very profeminist. We can test the convergence validity of our measure with multiple indicators that tap the construct's subparts. If one belief area (e.g., sexual relations) is consistently distinct from all other areas in empirical tests, then we question its unidimensionality.

Which descriptive statistics can I apply on my data?

Descriptive statistics help you get an idea of the "middle" and "spread" of your data through measures of central tendency and variability. When measuring the central tendency or variability of your data set, your level of measurement decides which methods you can use based on the mathematical operations that are appropriate for each level. The methods you can apply are cumulative; at higher levels, you can apply all mathematical operations and measures used at lower levels.

Data type	Mathematical operations	Measures of central tendency	Measures of variability
Nominal	Equality ($=$, $\neq$)	Mode	None
Ordinal	- Equality ($=$, $\neq$) - Comparison ($>$, $<$)	- Mode - Median	- Range - Interquartile range
Interval	- Equality ($=$, $\neq$) - Comparison ($>$, $<$) - Addition, subtraction ($+$, $-$)	- Mode - Median - Arithmetic mean	- Range - Interquartile range - Standard deviation - Variance
Ratio	- Equality ($=$, $\neq$) - Comparison ($>$, $<$) - Addition, subtraction ($+$, $-$) - Multiplication, division ($\times$, $\div$)	- Mode - Median - Arithmetic mean *Geometric mean	- Range - Interquartile range - Standard deviation - Variance **Relative standard deviation

References

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Lesson 24**INDEX AND SCALING****Topic 024: Index and Scaling****Introduction**

For most purposes, researchers can treat scales and indexes as being interchangeable. Social researchers do not use a consistent nomenclature to distinguish between them. A scale is a measure in which a researcher captures the intensity, direction, level, or potency of a variable construct and arranges responses or observations on a continuum. **A scale** can use a single indicator or multiple indicators. Most are at the ordinal level of measurement. **An index** is a measure in which a researcher adds or combines several distinct indicators of a construct into a single score. This composite score is often a simple sum of the multiple indicators. It is used for content and convergent validity. Indexes are often measured at the interval or ratio level. Researchers sometimes combine the features of scales and indexes in a single measure. This is common when a researcher has several indicators that are scales (i.e., that measure intensity or direction). He or she then adds these indicators together to yield a single score, thereby creating an index.

Index Construction

You hear about indexes all the time. For example, U.S. newspapers report the Federal Bureau of Investigation (FBI) crime index and the consumer price index (CPI). The FBI index is the sum of police reports on seven so-called index crimes (criminal homicide, aggravated assault, forcible rape, robbery, burglary, larceny of \$50 or more, and auto theft). The index began as part of the Uniform Crime Report in 1930 (see Rosen, 1995). The CPI, which is a measure of inflation, is created by totaling the cost of buying a list of goods and services (e.g., food, rent, and utilities) and comparing the total to the cost of buying the same list in the previous period.

The CPI has been used by the U.S. Bureau of Labor Statistics since 1919; wage increases, union contracts, and social security payments are based on it. An index is a combination of items into a single numerical score. Various components or subparts of a construct are each measured and then combined into one measure. There are many types of indexes. For example, the total number of questions correct on an exam with 25 questions is a type of index. It is a composite measure in which each question measures a small piece of knowledge and all questions scored correct or incorrect are totaled to produce a single measure. Indexes measure the most desirable place to live (based on unemployment, commuting time, crime rate, recreation opportunities, weather, and so on), the degree of crime (based on combining the occurrence of different specific crimes), the mental health of a person (based on the person's adjustment in various areas of life), and the like. Creating indexes is so easy that we must be careful to check that every item in an index has face validity and excludes any without face validity. We want to measure each part of the construct with at least one indicator. Of course, it is better to measure the parts of a construct with multiple indicators. An example of an index is a college quality index.

A theoretical definition says that a high-quality college has six distinguishing characteristics: (1) few students per faculty member, (2) a highly educated faculty, (3) high number of books in the library, (4) few students dropping out of college, (5) many students who go on to seek advanced degrees, and (6) faculty members who publish books or scholarly articles. We score 100 colleges on each item and then add the scores for each to create an index score of college quality that can be used to compare colleges. We can combine indexes. For example, to strengthen my college quality index, I add a subindex on teaching quality. The

index contains eight items: (1) average size of classes, (2) percentage of class time devoted to discussion, (3) number of different classes each faculty member teaches, (4) availability of faculty to students outside the classroom, (5) currency and amount of reading assigned, (6) degree to which assignments promote learning, (7) degree to which faculty get to know each student, and (8) student ratings of instruction. Similar sub index measures can be created for other parts of the college quality index. They can be combined into a more global measure of college quality. This further elaborates the definition of the construct “quality of college.”

Issues in Index Construction

There are three issues involved when we construct an index:

1. Weight of items
2. Missing data
3. The use of rates and standardization

1. Weighting is an important issue in index construction.

Unless otherwise stated, we assume that the items in an index are unweighted. Likewise, unless we have a good theoretical reason for assigning different weights to items, we use equal weights. An unweighted index gives each item equal weight. We simply sum the items without modification, as if each were multiplied by 1 (or -1 for items that are negative). A weighted index values or weights some items more than others. The size of weights can come from theoretical assumptions, the theoretical definition, or a statistical technique such as factor analysis. **For example**, we can elaborate the theoretical definition of the college quality index. We decide that the student/faculty ratio and number of faculty with Ph.D.s are twice as important as the number of books in the library per student or the percentage of students pursuing advanced degrees. Also, the percentage of freshmen who drop out and the number of publications per faculty member are three times more important than books in the library or percentage of students pursuing an advanced degree. This is easier to see when it is expressed as a formula. The number of students per faculty member and the percentage who drop out have negative signs because, as they increase, the quality of the college declines. The weighted and unweighted indexes can produce different results. Consider Old Ivy College, Local College, and Big University. All have identical unweighted index scores, but the colleges have different quality scores after weighting. Weighting produces different index scores in this example, but in most cases, weighted and unweighted indexes yield similar results. Researchers are concerned with the relationship between variables, and weighted and unweighted indexes usually give similar results for the relationships between variables.

2. Missing data

Missing data can be a serious problem when constructing an index. Validity and reliability are threatened whenever data for some cases are missing. There are four ways to attempt to resolve the problem but none fully solves it. **For example**, I construct an index of the degree of societal development in 1985 for 50 nations. The index contains four items: life expectancy, percentage of homes with indoor plumbing, percentage of population that is literate, and number of telephones per 100 people. I locate a source of United Nations statistics for my information. The values for Belgium are $68 + 87 + 97 + 28$ and for Turkey are $55 + 36 + 49 + 3$; for Finland, however, I discover that literacy data are unavailable. I check other sources of information, but none has the data because they were not collected.

Ways to Deal with Missing Data

1. **Eliminate all cases for which any information is missing.** If one nation in the discussion is removed from the study, the index will be reliable for the nations on which information is available. This is a problem if other nations have missing information. A study of 50 nations may become a study of 20 nations. Also, the cases with missing information may be similar in some respect (e.g., all are in eastern Europe or in the Third World), which limits the generalizability of findings.
2. **Substitute the average score for cases in which data are present.** The average literacy score from the other nations is substituted. This “solution” keeps Finland in the study but gives it an incorrect value. For an index with few items or for a case that is not “average,” this creates serious validity problems.
3. **Insert data based on non-quantitative information about the case.**

Other information about Finland (e.g., percentage of 13- to 18-year-olds in high school) is used to make an informed guess about the literacy rate. This “solution” is marginally acceptable in this situation. It is not as good as measuring Finland’s literacy, and it relies on an untested assumption—that one can predict the literacy rate from other countries’ high school attendance rate.

4. **Insert a random value**

This is unwise for the development index example. It might be acceptable if the index had a very large number of items and the number of cases was very large. If that were the situation, however, then eliminating the case is probably a better “solution” that produces a more reliable measure (Allison, 2001)

Rates and standardization are related ideas

You have heard of crime rates, rates of population growth, or the unemployment rate. Some indexes and single-indicator measures are expressed as rates. Rates involve standardizing the value of an item to make comparisons possible. The items in an index frequently need to be standardized before they can be combined. Standardization means the procedures to adjust measures statistically to permit making an honest comparison by giving a common basis to measures of different units.

Scale

A class of quantitative data measures often used in survey research that captures the intensity, direction, level, or potency of a variable construct along a continuum; most are at the ordinal level of measurement. Scales also help in the conceptualization and operationalization processes.

For example, you believe a single ideological dimension underlies people’s judgments about specific policies (e.g., housing, education, foreign affairs). Scaling can help you determine whether a single construct—for instance, “conservative/liberal ideology”—underlies the positions that people take on specific policies.

Scaling measures the intensity, direction, level, or potency of a variable. Graphic rating scales are an elementary form of scaling. People indicate a rating by checking a point on a line that runs from one extreme to another. This type of scale is easy to construct and use. It conveys the idea of a continuum, and assigning numbers helps people think about quantities. Scales assume that people with the same subjective feeling mark the graphic scale at the same place.

Types of Scales

There are five types of scales used in research.

1. Likert scale

A scale often used in survey research in which people express attitudes or other responses in terms of ordinal-level categories (e.g., agree, disagree) that are ranked along a continuum. They were developed in the 1930s by Rensis Likert to provide an ordinal-level measure of a person's attitude. Likert scales are called summated-rating or additive scales because a person's score on the scale is computed by summing the number of responses he or she gives. Likert scales usually ask people to indicate whether they agree or disagree with a statement. As the number of scale steps is increased from 2 up through 20, the increase in reliability is very rapid at first. It tends to level off at about 7, and after about 11 steps, there is little gain in reliability from increasing the number of steps

Examples of Types of Likert Scales

THE ROSENBERG SELF-ESTEEM SCALE

All in all, I am inclined to feel that I am a failure:

- | | |
|------------------------|-----------------|
| (1) Almost always true | (4) Seldom true |
| (2) Often true | (5) Never true |
| (3) Sometimes true | |

A STUDENT EVALUATION OF INSTRUCTION SCALE

Overall, I rate the quality of instruction in this course as:

Excellent Good Average Fair Poor

A MARKET RESEARCH MOUTHWASH RATING SCALE

Brand	Dislike Completely	Dislike Somewhat	Dislike a Little	Like a Little	Like Somewhat	Like Completely
X	_____	_____	_____	_____	_____	_____
Y	_____	_____	_____	_____	_____	_____

WORK GROUP SUPERVISOR SCALE

My supervisor:

	Never	Seldom	Sometimes	Often	Always
Lets members know what is expected of them	1	2	3	4	5
Is friendly and approachable	1	2	3	4	5
Treats all unit members as equals	1	2	3	4	5

Examples of Using the Likert Scale to Create Indexes

Sniderman and Hagen (1985) created indexes to measure beliefs about equal opportunity for women and self-esteem. For both indexes, scores were added to create an un-weighted index.

INDEX OF EQUAL OPPORTUNITY FOR WOMEN

Questions

1. Women have less opportunity than men to get the education they need to be hired in top jobs.

Strongly Agree	Somewhat Agree	Somewhat Disagree	Disagree a Great Deal	Don't Know
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2. Many qualified women cannot get good jobs; men with the same skills have less trouble.

Strongly Agree	Somewhat Agree	Somewhat Disagree	Disagree a Great Deal	Don't Know
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3. Our society discriminates against women.

Strongly Agree	Somewhat Agree	Somewhat Disagree	Disagree a Great Deal	Don't Know
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Scoring: For all items, Strongly Agree = 1, Somewhat Agree = 2, Somewhat Disagree = 4, Disagree a Great Deal = 5, Don't Know = 3.

Highest Possible Index Score = 15, respondent feels opportunities for women are equal
Lowest Possible Index Score = 3, respondent feels opportunities are not equal

SELF-ESTEEM INDEX

Questions

1. On the whole, I am satisfied with myself.

Agree	Disagree	Don't Know
-------	----------	------------

2. At times, I think I am no good at all.

Agree	Disagree	Don't Know
-------	----------	------------

3. I sometimes feel that (other) men do not take my opinion seriously.

Agree	Disagree	Don't Know
-------	----------	------------

Scoring: Items 1 and 3: 1 = Disagree, 2 = Don't Know, 3 = Agree, Item 2: 1 = Disagree, 2 = Don't Know, 3 = Agree.

Highest Possible Index Score = 9, high self-esteem
Lowest Possible Index Score = 3, low self-esteem

2. Thurstone scaling

Measuring in which the researcher gives a group of judges many items and asks them to sort the items into categories along a continuum and then considers the sorting results to select items on which the judges agree

Example of Thurstone Scaling

Variable Measured: Opinion with regard to the death penalty.

Step 1: Develop 120 statements about the death penalty using personal experience, the popular and professional literature, and statements by others.

Example Statements

1. I think that the death penalty is cruel and unnecessary punishment.
2. Without the death penalty, there would be many more violent crimes.
3. I believe that the death penalty should be used only for a few extremely violent crimes.
4. I do not think that anyone was ever prevented from committing a murder because of fear of the death penalty.
5. I do not think that people should be exempt from the death penalty if they committed a murder even if they are insane.
6. I believe that the Bible justifies the use of the death penalty.
7. The death penalty itself is not the problem for me, but I believe that electrocuting people is a cruel way to put them to death.

Step 2: Place each statement on a separate card or sheet of paper and make 100 sets of the 120 statements.

Step 3: Locate 100 persons who agree to serve as judges. Give each judge a set of the statements and instructions to place them in one of 11 piles, from 1 = highly unfavorable statement through 11 = highly favorable statement.

Step 4: The judges place each statement into one of the 11 piles (e.g., Judge 1 puts statement 1 into pile 2; Judge 2 puts the same statement into pile 1; Judge 3 also puts it into pile 2, Judge 4 puts it in pile 3, and so on).

Step 5: Collect piles from judges and create a chart summarizing their responses. See the example chart that follows.

NUMBER OF JUDGES RATING EACH STATEMENT RATING PILE

Statement	Unfavorable				Neutral				Favorable				Total
	1	2	3	4	5	6	7	8	9	10	11		
1	23	60	12	5	0	0	0	0	0	0	0	100	
2	0	0	0	0	2	12	18	41	19	8	0	100	
3	2	8	7	13	31	19	12	6	2	0	0	100	
4	9	11	62	10	4	4	0	0	0	0	0	100	

Step 6: Compute the average rating and degree of agreement by judges. For example, the average for question 1 is about 2, so there is high agreement; the average for question 3 is closer to 5, and there is much less agreement.

Step 7: Choose the final 20 statements to include in the death penalty opinion scale. Choose statements if the judges showed agreement (most placed an item in the same or a nearby pile) and ones that reflect the entire range of opinion, from favorable to neutral to unfavorable.

Step 8: Prepare a 20-statement questionnaire, and ask people in a study whether they agree or disagree with the statements.

3. Bogardus social distance scale

A scale measuring the social distance between two or more social groups by having members of one group indicate the limit of their comfort with various types of social interaction or closeness with members of the other group(s).

Example of Bogardus Social Distance Scale

A researcher wants to find out how socially distant freshmen college students feel from exchange students from two different countries: Nigeria and Germany. She wants to see whether students feel more distant from students coming from Africa or from Europe. She uses the following series of questions in an interview:

Please give me your first reaction, yes or no, whether you personally would feel comfortable having an exchange student from (name of country):

- _____ As a visitor to your college for a week
- _____ As a full-time student enrolled at your college
- _____ Taking several of the same classes you are taking
- _____ Sitting next to you in class and studying with you for exams
- _____ Living a few doors down the hall on the same floor in your dormitory
- _____ As a same-sex roommate sharing your dorm room
- _____ As someone of the opposite sex who has asked you to go out on a date

Hypothetical Results

	Percentage of Freshmen Who Report Feeling Comfortable	
	Nigeria	Germany
Visitor	100%	100%
Enrolled	98	100
Same class	95	98
Study together	82	88
Same dorm	71	83
Roommate	50	76
Go on date	42	64

The results suggest that freshmen feel more distant from Nigerian students than from German students. Almost all feel comfortable having the international students as visitors, enrolled in the college, and taking classes. Feelings of distance increase as interpersonal contact increases, especially if the contact involves personal living settings or activities not directly related to the classroom.

4. Semantic differential

A scale that indirectly measures feelings or thoughts by presenting people a topic or object and a list of polar opposite adjectives or adverbs and then having them indicate feelings by marking one of several spaces between the two adjectives or adverbs.

Example of Semantic Differential

Please read each pair of adjectives below and then place a mark on the blank space that comes closest to your first impression feeling. There are no right or wrong answers.

How do you feel about the idea of divorce?

Bad	_____	_____	_____	_____	_____	_____	_____	_____	Good
Deep	_____	_____	_____	_____	_____	_____	_____	_____	Shallow
Weak	_____	_____	_____	_____	_____	_____	_____	_____	Strong
Fair	_____	_____	_____	_____	_____	_____	_____	_____	Unfair
Quiet	_____	_____	_____	_____	_____	_____	_____	_____	Loud
Modern	_____	_____	_____	_____	_____	_____	_____	_____	Traditional
Simple	_____	_____	_____	_____	_____	_____	_____	_____	Complex
Fast	_____	_____	_____	_____	_____	_____	_____	_____	Slow
Dirty	_____	_____	_____	_____	_____	_____	_____	_____	Clean

How do you feel about the idea of marriage?

Bad	_____	_____	_____	_____	_____	_____	_____	_____	Good
Deep	_____	_____	_____	_____	_____	_____	_____	_____	Shallow
Weak	_____	_____	_____	_____	_____	_____	_____	_____	Strong
Fair	_____	_____	_____	_____	_____	_____	_____	_____	Unfair
Quiet	_____	_____	_____	_____	_____	_____	_____	_____	Loud
Modern	_____	_____	_____	_____	_____	_____	_____	_____	Traditional
Simple	_____	_____	_____	_____	_____	_____	_____	_____	Complex
Fast	_____	_____	_____	_____	_____	_____	_____	_____	Slow
Dirty	_____	_____	_____	_____	_____	_____	_____	_____	Clean

5. Guttman scaling index

A scale that researchers use after data are collected to reveal whether a hierarchical pattern exists among responses so that people who give responses at a “higher level” also tend to give “lower level” ones.

Guttman Scale Example

Crozat (1998) examined public responses to various forms of political protest. He looked at survey data on the public's acceptance of forms of protest in Great Britain, Germany, Italy, the Netherlands, and the United States in 1974 and 1990. He found that the pattern of the public's acceptance formed a Guttman scale. Those who accepted more intense forms of protest (e.g., strikes and sit-ins) almost always accepted more modest forms (e.g., petitions or demonstrations), but not all who accepted modest forms accepted the more intense forms. In addition to showing the usefulness of the Guttman scale, Crozat also found that people in different nations saw protest similarly and the degree of Guttman scalability increased over time. Thus, the pattern of acceptance of protest activities was Guttman "scalable" in both time periods, but it more closely followed the Guttman pattern in 1990 than in 1974.

	FORM OF PROTEST				
	<i>Petitions</i>	<i>Demonstrations</i>	<i>Boycotts</i>	<i>Strikes</i>	<i>Sit-Ins</i>
<i>Guttman Patterns</i>					
	N	N	N	N	N
	Y	N	N	N	N
	Y	Y	N	N	N
	Y	Y	Y	N	N
	Y	Y	Y	Y	N
	Y	Y	Y	Y	Y
<i>Other Patterns (examples only)</i>					
	N	Y	N	Y	N
	Y	N	Y	Y	N
	Y	N	Y	N	N
	N	Y	Y	N	N
	Y	N	N	Y	Y

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Lesson 25**TOOL FOR DATA COLLECTION****Topic 025: Tool for data collection****Introduction**

Data collection is a methodical process of gathering and analyzing specific information to proffer solutions to relevant questions and evaluate the results. It focuses on finding out all there is to a particular subject matter. Data is collected to be further subjected to hypothesis testing which seeks to explain a phenomenon. Quantitative data collection is everything about figures and numbers. Researchers often rely on quantitative data when they intend to quantify attributes, attitudes, behaviors, and other defined variables with a motive to either back or oppose the hypothesis of a specific phenomenon by contextualizing the data obtained via surveying or interviewing the study sample.

What is the need for quantitative data collection?

As a researcher, you do have the option to opt either for data collection online or use traditional data collection methods via appropriate research. However, you will need computational, statistical, and mathematical tools to derive results from the collected quantitative data.

Method Data Collection**1. Interviews**

Interviewing people is a standard method used for data collection. However, the interviews conducted to collect quantitative data are more structured, wherein the researchers ask only a standard set of questionnaires and nothing more than that.

There are three major types of interviews conducted for data collection

- **Telephone interviews:** For years, telephone interviews ruled the charts of data collection methods. However, nowadays, there is a significant rise in conducting video interviews using the internet, Skype, or similar online video calling platforms.
- **Face-to-face interviews:** It is a proven technique to collect data directly from the participants. It helps in acquiring quality data as it provides a scope to ask detailed questions and probing further to collect rich and informative data. Literacy requirements of the participant are irrelevant as F2F interviews offer ample opportunities to collect non-verbal data through observation or to explore complex and unknown issues. Although it can be an expensive and time-consuming method, the response rates for F2F interviews are often higher.
- **Computer-Assisted Personal Interviewing (CAPI):** It is nothing but a similar setup of the face-to-face interview where the interviewer carries a desktop or laptop along with him at the time of interview to upload the data obtained from the interview directly into the database. CAPI saves a lot of time in updating and processing the data and also makes the entire process paperless as the interviewer does not carry a bunch of papers and questionnaires.



When to use

Quantitative interviews work well when the market researcher is conducting fieldwork to scope potential respondents. For example, approaching buyers of a certain product at a supermarket.

Advantages

- **Higher responsiveness:** Potential respondents are more likely to say ‘yes’ to a market researcher in-person than in other ways, e.g. a phone call.
- **Clearer understanding:** Interviews allow respondents to seek clarification from the interviewer if they are confused by a question.
- **Less downtime:** The market researcher can collect data as soon as the interview is conducted, rather than wait to hear back from the respondent first.

Disadvantages

- **Interviewer effect:** Having an interviewer present questions to the respondent poses the risk of influencing the way in which the respondent answers.
- **Time consuming:** Interviews usually take longer to complete than other methods, such as surveys.
- **Less control:** Interviews present more variables, such as tone and pace, which could affect data quality.

2. Observations

It is a pretty simple and straightforward method of collecting quantitative data. In this method, researchers collect quantitative data through systematic observations by using techniques like counting the number of people present at the specific event at a particular time and a particular venue or number of people attending the event in a designated place. More often, for quantitative data collection, the researchers have a naturalistic observation approach that needs keen observation skills and senses for getting the numerical data about the “what” and not about “why” and “how.”

Naturalistic observation is used to collect both types of data; qualitative and quantitative. However, structured observation is more used to collect quantitative rather than qualitative data.

Structured observation: In this type of observation method, the researcher has to make careful observations of one or more specific behaviors in a more comprehensive or structured setting

compared to naturalistic or participant observation. In a structured observation, the researchers, rather than observing everything, focus only on very specific behaviors of interest. It allows them to quantify the behaviors they are observing. When the observations require a judgment on the part of the observers – it is often described as coding, which requires a clearly defining a set of target behaviors.

Advantages

- Easy to administer.
- There subsists a greater accuracy with results.
- It is a universally accepted practice.
- It diffuses the situation of an unwillingness of respondents to administer a report.
- It is appropriate for certain situations.

Disadvantages

- Some phenomena aren't open to observation.
- It cannot be relied upon.
- Bias may arise.
- It is expensive to administer.
- Its validity cannot be predicted accurately.

3. Document Review in Quantitative Data Collection

Document review is a process used to collect data after reviewing the existing documents. It is an efficient and effective way of gathering data as documents are manageable and are the practical resource to get qualified data from the past. Apart from strengthening and supporting the research by providing supplementary research data document review has emerged as one of the beneficial methods to gather quantitative research data.

Three primary document types are being analyzed for collecting supporting quantitative research data

- **Public Records:** Under this document review, official, ongoing records of an organization are analyzed for further research. For example, annual reports policy manuals, student activities, game activities in the university, etc.
- **Personal Documents:** In contrast to public documents, this type of document review deals with individual personal accounts of individuals' actions, behavior, health, physique, etc. For example, the height and weight of the students, distance students are traveling to attend the school, etc.
- **Physical Evidence:** Physical evidence or physical documents deal with previous achievements of an individual or of an organization in terms of monetary and scalable growth.

When to use

Secondary data collection methods are most appropriately used when the market researcher is exploring a topic which already has extensive information and data available and is looking for supplementary insights for guidance.

For example, a study on caffeine consumption habits could draw statistics from existing medical case studies.

Advantages

- **Easier collection:** As secondary data is readily available, it is relatively easy to collect for further analysis.
- **More credibility:** If collected from reputable sources, secondary data can be trusted as accurate and of quality.
- **Less expensive:** Collecting secondary data often costs a lot less than if the same data were collected primarily.

Disadvantages

- **Differing context:** Secondary data collected will not necessarily align with the market researcher's research questions or objectives.
- **Limited availability:** The amount and detail of secondary data available for a particular research topic is varied and not dependable.
- **Less control:** As secondary data is originally collected externally, there is no control over the quality of available data on a topic.

4. QUESTIONNAIRES

This is the process of collecting data through an instrument consisting of a series of questions and prompts to receive a response from individuals it is administered to. Questionnaires are designed to collect data from a group.

For clarity, it is important to note that a questionnaire isn't a survey, rather it forms a part of it. A survey is a process of data gathering involving a variety of data collection methods, including a questionnaire.

On a questionnaire, there are three kinds of questions used. They are; fixed-alternative, scale, and open-ended. With each of the questions tailored to the nature and scope of the research.

Advantages

- Can be administered in large numbers and is cost-effective.
- It can be used to compare and contrast previous research to measure change.
- Easy to visualize and analyze.
- Questionnaires offer actionable data.
- Respondent identity is protected.
- Questionnaires can cover all areas of a topic.
- Relatively inexpensive.

Disadvantages

- Answers may be dishonest or the respondents lose interest midway.
- Questionnaires can't produce qualitative data.
- Questions might be left unanswered.
- Respondents may have a hidden agenda.
- Not all questions can be analyzed easily.

Questionnaire

Questionnaire is as an instrument for research, which consists of a list of questions, along with the choice of answers, printed or typed in a sequence on a form used for acquiring specific information from the respondents. In general, questionnaires are delivered to the persons concerned either by post or mail, requesting them to answer the questions and return it. Informants are expected to read and understand the questions and reply in the space provided in the questionnaire itself. The questionnaire is prepared in such a way that it translates the required information into a series of questions, that informants can and will answer.

Characteristics of a Good Questionnaire

The following are characteristics of good questionnaires:

- It should consist of a well-written list of questions.
- The questionnaire should deal with an important or significant topic to create interest among respondents.
- It should seek only that data which cannot be obtained from other sources.
- It should be as short as possible but should be comprehensive.
- It should be attractive.
- Directions should be clear and complete.
- It should be represented in good psychological order proceeding from general to more specific responses.
- Double negatives in questions should be avoided.
- Putting two questions in one question also should be avoided. Every question should seek to obtain only one specific information.
- It should be designed to collect information which can be used subsequently as data for analysis.

Format of Questions in Questionnaires

The questions asked can take two forms:

Restricted questions, also called closed-ended, ask the respondent to make choices — yes or no, check items on a list, or select from multiple choice answers. Restricted questions are easy to tabulate and compile.

Unrestricted questions are open-ended and allow respondents to share feelings and opinions that are important to them about the matter at hand. Unrestricted questions are not easy to tabulate and compile, but they allow respondents to reveal the depth of their emotions. If the objective is to compile data from all respondents, then sticking with restricted questions that are easily quantified is better. If degrees of emotions or depth of sentiment is to be studied, then develop a scale to quantify those feelings.

Uses of Questionnaires

- Questionnaires are a common and inexpensive research tool used by private companies, government departments, individuals, groups, NGOs etc to get feedback, research, collect data from consumer, customers or from general public depending on the need.
- Questionnaires are the most important part of primary surveys.

Types of Questionnaire

- **Computer questionnaire**

Respondents are asked to answer the questionnaire which is sent by mail. The advantages of the computer questionnaires include their inexpensive price, time-efficiency, and respondents do not feel pressured, therefore can answer when they have time, giving more accurate answers. However, the main shortcoming of the mail questionnaires is that sometimes respondents do not bother answering them and they can just ignore the questionnaire.

- **Telephone questionnaire**

Researcher may choose to call potential respondents with the aim of getting them to answer the questionnaire. The advantage of the telephone questionnaire is that, it can be completed during the short amount of time. The main disadvantage of the phone questionnaire is that it is expensive most of the time. Moreover, most people do not feel comfortable to answer many questions asked through the phone and it is difficult to get sample group to answer questionnaire over the phone.

- **In-house/Personal survey**

This type of questionnaire involves the researcher visiting respondents in their houses or workplaces. The advantage of in-house survey is that more focus towards the questions can be gained from respondents. However, in-house surveys also have a range of disadvantages which include being time consuming, more expensive and respondents may not wish to have the researcher in their houses or workplaces for various reasons.

- **Mail Questionnaire**

This sort of questionnaires involve the researcher to send the questionnaire list to respondents through post, often attaching pre-paid envelope. Mail questionnaires have an advantage of providing more accurate answer, because respondents can answer the questionnaire in their spare time. The disadvantages associated with mail questionnaires include them being expensive, time consuming and sometimes they end up in the bin put by respondents.

- **Paper Questionnaire**

A paper questionnaire is a data collection tool consisting of a series of questions and/or prompts for the purpose of gathering information from respondents. Mostly designed for statistical analysis of the responses, they can also be used as a form of data collection.

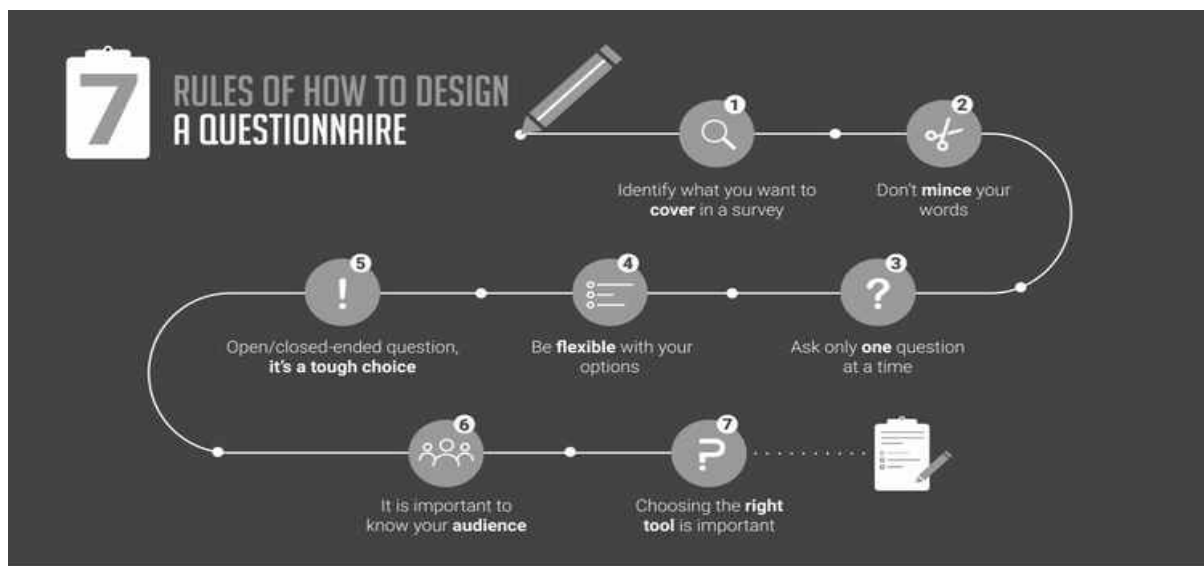
Advantages of a well-designed online questionnaire



- Collect a large amount of data in less time.** (Illustration: A woman holding a magnifying glass over a globe with various icons.)
- There is less chance of bias with the help of logic questions.** (Illustration: A computer screen showing a logic flowchart with 'Yes' and 'No' paths.)
- Online survey software is fast and cost effective to design, distribute and analyze.** (Illustration: A man sitting at a desk with a laptop, looking at a screen with a question mark icon.)
- It can be customized to reflect your brand voice.** (Illustration: Three people in a meeting, one holding a laptop and another a document.)
- Responses can be compared with historical data.** (Illustration: A man sitting at a desk with a laptop, looking at a screen displaying a bar chart.)
- Respondents can answer the questionnaire without revealing their identity.** (Illustration: A man sitting at a desk with a laptop, looking at a screen with a 'Anonymous' label and a question mark icon.)

Learn more:
www.questionpro.com/blog/what-is-a-questionnaire/

QuestionPro



Steps Involved in Questionnaire Design

1. Identify the scope of your research: Think about what your questionnaire is going to include before you start designing the look of it. The clarity of the topic is of utmost importance as this is the primary step in creating the questionnaire. Once you are clear on the purpose of the questionnaire, you can begin the design process.

2. Keep it simple: The words or phrases you use while writing the questionnaire must be easy to understand. If the questions are unclear, the respondents may simply choose any answer and skew the data you collect.

3. Ask only one question at a time: At times, a researcher may be tempted to add two similar questions. This might seem like an excellent way to consolidate answers to related issues, but it can confuse your respondents or lead to inaccurate data. If any of your questions contain the word “and,” take another look. This question likely has two parts, which can affect the quality of your data.

4. Be flexible with your options: While designing, the survey creator needs to be flexible in terms of “option choice” for the respondents. Sometimes the respondents may not necessarily want to choose from the answer options provided by the survey creator. An “other” option often helps keep respondents engaged in the survey.

5. The open-ended or closed-ended question is a tough choice: The survey creator might end up in a situation where they need to make distinct choices between open or close-ended questions. The question type should be carefully chosen as it defines the tone and importance of asking the question in the first place.

If the questionnaire requires the respondents to elaborate on their thoughts, an open-ended question is the best choice. If the surveyor wants a specific response, then close-ended questions should be their primary choice. The key to asking closed-ended questions is to generate data that is easy to analyze and spot trends.

6. It is essential to know your audience: A researcher should know their target audience. For example, if the target audience speaks mostly Spanish, sending the questionnaire in any other language would lower the response rate and accuracy of data. Something that may seem clear to you may be confusing to your respondents. Use simple language and terminology that your respondents will understand, and avoid technical jargon and industry-specific language that might confuse your respondents.

For efficient market research, researchers need a representative sample collected using one of the many sampling techniques. It is imperative to plan and define these target respondents based on the demographics required.

7. Choosing the right tool is essential: QuestionPro is a simple yet advanced survey software platform that the surveyors can use to create a questionnaire or choose from the already existing 300+ questionnaire templates.

Always save personal questions for last. Sensitive questions may cause respondents to drop off before completing. If these questions are at the end, the respondent has had time to become more comfortable with the interview and are more likely to answer personal or demographic questions.

Questionnaire Design Issues

1. Length of Survey or Questionnaire
2. Question Order or Sequence
3. Layout and Format

Types of Questions in Questionnaire

1. Sleeper question

Survey research inquiry about nonexistent people or events to check whether respondents are being truthful.

2. Contingency question

A two-part survey item in which a respondent's answer to a first question directs him or her either to the next questionnaire item or to a more specific and related second question.

Example of a Contingency Question

QUESTION VERSION 1 (NOT CONTINGENCY QUESTION)

In the past year, how often have you used a seat belt when you have ridden in the backseat of a car?

QUESTION VERSION 2 (CONTINGENCY QUESTION)

In the past, have you ridden in the backseat of a car?

No [Skip to next question]

Yes → When you rode in the backseat, how often did you use a seat belt?

Results	Always Use	Never Use
Version 1	30%	24%
Version 2	42	4

During pilot testing, researchers learned that many respondents who answered "never" to Version 1 did not ride in the backseat of a car. Version 1 created ambiguity because respondents who never rode in the backseat plus those who rode there but did not use a seat belt both answered "Never." Version 2 using a contingency question format clarified the question.

Source: Adapted from Presser, *Evaluating Survey Questionnaires*, Hoboken, NJ: Wiley. (2004). Reprinted by permission of John Wiley & Sons, Inc.

3. Open-ended question

A type of survey research inquiry that allows respondents freedom to offer any answer they wish to the question.

4. Closed-ended question

A type of survey research inquiry in which respondents must choose from a fixed set of answers.

5. Partially open question

A type of survey research enquiry in which respondents are given a fixed set of answers to choose from, but the addition an "other" category is offered so that they can specify a different answer.

ADVANTAGES OF CLOSED

- They are easier and quicker for respondents to answer.
- The answers of different respondents are easier to compare.
- Answers are easier to code and statistically analyze.
- The response choices can clarify a question's meaning for respondents.
- Respondents are more likely to answer about sensitive topics.
- There are fewer irrelevant or confused answers to questions.
- Less articulate or less literate respondents are not at a disadvantage.
- Replication is easier.

ADVANTAGES OF OPEN

- They permit an unlimited number of possible answers.
- Respondents can answer in detail and can qualify and clarify responses.
- They can help us discover unanticipated findings.
- They permit adequate answers to complex issues.
- They permit creativity, self-expression, and richness of detail.
- They reveal a respondent's logic, thinking process, and frame of reference.

DISADVANTAGES OF CLOSED

- They can suggest ideas that the respondent would not otherwise have.
- Respondents with no opinion or no knowledge can answer anyway.
- Respondents can be frustrated because their desired answer is not a choice.
- It is confusing if many (e.g., 20) response choices are offered.
- Misinterpretation of a question can go unnoticed.
- Distinctions between respondent answers may be blurred.
- Clerical mistakes or marking the wrong response is possible.
- They force respondents to give simplistic responses to complex issues.
- They force respondents to make choices they would not make in the real world.

DISADVANTAGES OF OPEN

- Different respondents give different degrees of detail in answers.
- Responses may be irrelevant or buried in useless detail.
- Comparisons and statistical analysis become very difficult.
- Coding responses is difficult.
- Articulate and highly literate respondents have an advantage.
- Questions may be too general for respondents who lose direction.
- Responses are written verbatim, which is difficult for interviewers.
- An increased amount of respondent time, thought, and effort is necessary.
- Respondents can be intimidated by questions.
- Answers take up a lot of space in the questionnaire.

Neutral Positions, Floaters, and Selective Refusals

Failing to get valid responses from each respondent weakens a survey. Respondents may answer three ways that yield invalid responses.

1. Swayed opinion

This involves falsely overstating a position as with the social desirability bias, or falsely understating or withholding a position as with sensitive topics.

2. False positive

This results from selecting an attitude position but lacking any knowledge on an issue and really having no true opinion or view on it.

3. False negative

Caused when a respondent refuses to answer some questions or withholds an answer when he or she actually has information or really holds an opinion. The three types of responses overlap. The first involves an inaccurate direction of a response toward a normative position, the second substitute's wild guesses for a serious response, and the last type is the partial and selective nonresponse to the survey.

Neutral Positions

Survey researchers debate whether they should offer respondents who lack knowledge or have no position a neutral position and a "no opinion" choice. Some argue against offering a neutral or middle position and the no opinion option and favor pressuring respondents to give a response. This perspective holds that respondents engage in satisficing; that is, they pick no opinion or a neutral response to avoid the cognitive effort of answering. Those with this position maintain that the least educated respondents may pick a no opinion option when they actually have one they believe that pressuring respondents for an answer does not lower data quality. Others argue that it is best to offer a neutral ("no opinion") choice because people often

answer questions to please others or not to appear ignorant. Respondents may give opinions on fictitious issues, objects, and events. By offering a nonattitude (middle or no opinion) choice, we can identify respondents without an opinion and separate them from respondents who really have one.

Floaters

Survey questions address the issue of nonattitudes with three types of attitude questions: standard-format, quasi-filter, and full-filter questions. The **standard-format question** does not offer a “don’t know” choice; a respondent must volunteer it. A **quasi-filter question** offers a “don’t know” alternative. A **full-filter question** is a special type of contingency question. It first asks whether respondents have an opinion, and then asks for the opinion of those who state that they do have one.

Selective Refusals

In addition to the issue of satisficing, by which respondents pick no or a neutral response to avoid the effort of answering, some respondents refuse to answer certain questions. This often is the case involving a sensitive issue. Respondents refuse rather than indicate a socially inappropriate answer.

TABLE 1 Summary of Survey Question Writing Pitfalls

THINGS TO AVOID	NOT GOOD	A POSSIBLE IMPROVEMENT
Jargon, slang, abbreviations	Did you drown in brew until you were totally blasted last night?	Last night, about how much beer did you drink?
Vagueness	Do you eat out often?	In a typical week, about how many meals do you eat away from home, at a restaurant, cafeteria, or other eating establishment?
Emotional language and prestige bias	"The respected Grace Commission documents that a staggering \$350 BILLION of our tax dollars are being completely wasted through poor procurement practices, bad management, sloppy bookkeeping, 'defective' contract management, personnel abuses and other wasteful practices. Is cutting pork barrel spending and eliminating government waste a top priority for you?"	How important is it to you that Congress adopt measures to reduce government waste? Very Important Somewhat Important Neither Important or Unimportant Somewhat Unimportant Not Important at All
Double-barreled questions	Do you support or oppose raising Social Security benefits and increased spending for the military?	Do you support or oppose raising Social Security benefits? Do you support or oppose increasing spending on the military?
Leading questions	Did you do your patriotic duty and vote in the last election for mayor?	Did you vote in last month's mayoral election?
Issues beyond respondent capabilities	Two years ago, how many hours did you watch TV every month?	In the past two weeks, about how many hours do you think you watched TV on a typical day?
False premises	When did you stop beating your girl- or boyfriend?	Have you ever slapped, punched, or hit your girl- or boyfriend?
Distant future intentions	After you graduate from college, get a job, and are settled, will you invest a lot of money in the stock market?	Do you have definite plans to put some money into the stock market within the coming two months?
Double negatives	Do you disagree with those who do not want to build a new city swimming pool?	There is a proposal to build a new city swimming pool. Do you agree or disagree with the proposal?
Unbalanced responses	Did you find the service at our hotel to be Outstanding, Excellent, Superior, or Good?	Please rate the service at our hotel: Outstanding, Very Good, Adequate, or Poor.

IMPORTANCE OF DATA COLLECTION

There are a bunch of underlying reasons for collecting data, especially for a researcher. Walking you through them, here are a few reasons;

- **Integrity of the Research**

A key reason for collecting data, be it through quantitative or qualitative methods is to ensure that the integrity of the research question is indeed maintained.

- **Reduce the likelihood of errors**

The correct use of appropriate data collection of methods reduces the likelihood of errors consistent with the results.

- **Decision Making**

To minimize the risk of errors in decision-making, it is important that accurate data is collected so that the researcher doesn't make uninformed decisions.

- **Save Cost and Time**

Data collection saves the researcher time and funds that would otherwise be misspent without a deeper understanding of the topic or subject matter.

- **To support a need for a new idea, change, and/or innovation**

To prove the need for a change in the norm or the introduction of new information that will be widely accepted, it is important to collect data as evidence to support these claims.

Lesson 26**ETHICS IN QUANTITATIVE RESEARCH****Topic 026: Ethics in Quantitative Research****Introduction**

Ethics are norms or standards of behavior that guide moral choices about our behavior and our relationships with others. The goal of ethics in research is to ensure that no one is harmed or suffers adverse consequences from research activities. This objective is usually achieved. However, unethical activities are pervasive and include violating nondisclosure agreements, breaking respondent confidentiality, misrepresenting results, deceiving people, invoicing irregularities, avoiding legal liability, and more.

As discussed earlier, ethical questions are philosophical questions. There is no general agreement among philosophers about the answers to such questions. However the rights and obligations of individuals are generally dictated by the norms of society. Societal norms are codes of behavior adopted by a group; they suggest what a member of a group ought to do under given circumstances. Nevertheless, with changing situations people continue differing with each other whereby societal norms may undergo changes. Codes and regulations guide researchers and sponsors. Review boards and peer groups help researchers examine their research proposals for ethical dilemmas. Responsible researchers anticipate ethical dilemmas and attempt to adjust the design, procedures, and protocols during the planning process rather than treating them as afterthought. Ethical research requires personal integrity from the researcher, the project manager, and the research sponsor.

Codes of ethic applicable at each stage of the research Goal:

To ensure that no one is harmed or suffers adverse consequences from research activities.

Unethical activities

- Violating nondisclosure agreements.
- Breaking respondent confidentiality.
- Misrepresenting results.
- Deceiving people.
- Invoicing irregularities.
- Avoiding legal liability.

Ethical Issues

- Remain to be issues.
- Local norms suggest what ought to be done under the given circumstances.
- Codes of ethics developed to guide researchers and sponsors.
- Review Boards and peer groups help sorting out ethical dilemmas.

Anticipate ethical dilemmas

- Adjust the design, procedures, and protocols accordingly.
- Research ethics require personal integrity of the researcher, the project manager, and research sponsor.

Parties in Research

Mostly three parties:

- The researcher
- The sponsoring client (user)
- The respondent (subject)
- Interaction requires ethical questions.
- Each party expects certain rights and feels certain obligations.

Ethical Treatment of Participants

When ethics are discussed in research design, we often think first about protecting the rights of the participant, respondent, or subject. Whether data are gathered in an experiment, interview, observation, or survey, the respondent has many rights to be safeguarded. In general the research must be designed so that a respondent does not suffer physical harm, discomfort, pain, embarrassment, or loss of privacy. To safeguard against these, the researcher should follow three guidelines;

1. Explain study benefits.
2. Explain respondent rights and protections.
3. Obtain informed consent.

Benefits

Whenever direct contact is made with a respondent, the researcher should discuss the study's benefits, being careful to neither overstate nor understate the benefits. An interviewer should begin an introduction with his or her name, the name of the research organization, and a brief description of the purpose and benefit of the research. This puts the respondent at ease, let them know to whom they are speaking, and motivates them to answer questions truthfully. In short, knowing why one is being asked questions improve cooperation through honest disclosure of purpose. Inducements to participate, financial or otherwise, should not be disproportionate to the task or presented in a fashion that results in coercion. Sometimes the actual purpose and benefits of the study or experiment must be concealed from the respondents to avoid introducing bias. The need for concealing objectives leads directly to the problem of deception.

Ethical Issues in Research

Ethics are norms or standards of behavior that guide moral choices about our behavior and our relationships with others. The goal of ethics in research is to ensure that no one is harmed or suffers adverse consequences from research activities. This objective is usually achieved. However, unethical activities are pervasive and include violating nondisclosure agreements, breaking respondent confidentiality, misrepresenting results, deceiving people, invoicing irregularities, avoiding legal liability, and more.

Deception

Deception occurs when the respondents are told only part of the truth or when the truth is fully compromised. Some believe this should never occur. Others suggest two reasons for deception: (1) to prevent biasing the respondents before the survey or experiment and (2) to protect the confidentiality of a third party (e.g. the sponsor). Deception should not be used in an attempt to improve response rates. The benefits to be gained by deception should be balanced against the risks to the respondents. When possible, an experiment or interview should be redesigned to reduce the reliance on deception. Use of deception is inappropriate unless deceptive techniques are justified by the study's expected scientific, educational, or applied value and

equally effective alternatives that do not use deception are not feasible. And finally, the respondents must have given their informed consent before participating in the research.

Informed Consent

Securing informed consent from respondents is a matter of fully disclosing the procedures of the proposed survey or other research design before requesting permission to proceed with the study. There are exceptions that argue for a signed consent form. When dealing with children, it is wise to have a parent or other person with legal standing sign a consent form. If there is a chance the data could harm the respondent or if the researchers offer any limited protection of confidentiality, a signed form detailing the types of limits should be obtained. For most business research, oral consent is sufficient. In situations where respondents are intentionally or accidentally deceived, they should be debriefed once the research is complete.

Debriefing

It involves several activities following the collection of data:

- Explanation of any deception.
- Description of the hypothesis, goal, or purpose of the study.
- Post study sharing of the results.
- Post study follow-up medical or psychological attention.

First, the researcher shares the truth of any deception with the participants and all the reasons for using deception in the context of the study's goals. In cases where severe reactions occur, follow-up medical or psychological attention should be provided to continue to ensure the participants remain unharmed by the research. Even when the research does not deceive the respondents, it is a good practice to offer them follow-up information. This retains the goodwill of the respondent, providing an incentive to participate in future research projects. For surveys and interviews, respondents can be offered a brief report of the findings. Usually they would not ask for additional information. For experiments, all participants should be debriefed in order to put the experiment in context. Debriefing usually includes a description of the hypothesis being tested and the purpose of the study. Participants who were not deceived still benefit from the debriefing session. They will be able to understand why the experiment was created. The researchers also gain important insight into what the participants thought about during and after the experiment. To what extent do debriefing and informed consent reduce the effects of deception? Research suggests that the majority of the respondents do not resent temporary deception and may have more positive feelings about the value of the research after debriefing than those who didn't participate in the study.

Rights to Privacy

All individuals have right to privacy, and researchers must respect that right. The privacy guarantee is important not only to retain validity of the research but also to protect respondents. The confidentiality of the survey answers is an important aspect of the respondents' right to privacy. Once the guarantee of confidentiality is given, protecting that confidentiality is essential. The researcher protects the confidentiality in several ways;

- Obtaining signed nondisclosure documents.
- Restricting access to respondent identification.
- Revealing respondent information only with written consent.
- Restricting access to data instruments where the respondent is identified.

- Nondisclosure of data subsets. Privacy is more than confidentiality. A right to privacy means one has the right to refuse to be interviewed or to refuse to answer any question in an interview. Potential participants have a right to privacy in their own homes including not admitting researchers and not answering telephones. To address these rights, ethical researchers do the following:

- Inform respondents of their right to refuse to answer any questions or participate in the study.
- Obtain permission to interview respondents.
- Schedule field and phone interviews.
- Limit the time required for participation.
- Restrict observation to public behavior only.

The obligation to be truthful:

When a subject willingly agrees to participate, it is generally expected that he or she will provide truthful answers. Honest cooperation is main obligation of the respondent or the subject.

Ethics and the Sponsor

There are also ethical considerations to keep in mind when dealing with the research client or sponsor has the right to receive ethically conducted research.

Confidentiality of Sponsor

Some sponsors wish to undertake research without revealing themselves. They have a right to several types of confidentiality, including sponsor nondisclosure, purpose nondisclosure, and findings nondisclosure. Companies have the right to dissociate themselves from sponsorship of a research project. This type of confidentiality is called sponsorship nondisclosure. Due to sensitive nature of the management dilemma or the research question, sponsor may hire an outside consulting or research firm to complete research project. This is often done when a company is testing a new product idea, to avoid potential consumers from being influenced by company's current image or industry standing.

Purpose nondisclosure involves protecting the purpose of the study or its details. A research sponsor may be testing a new idea that is not yet patented and may not want the competition to know its plans. It may be investigating employee complaints and may not want to spark union activity. Finally, even if a sponsor feels no need to hide its identity or the study's purpose, most sponsors want the research data and findings to be confidential; at least until the management decision is made. Thus sponsors usually demand and receive findings nondisclosure between themselves or their researchers and any interested but unapproved parties.

Right to Quality Research

An important ethical consideration is the sponsor's right to quality research. This right entails:

- Providing research design appropriate for the research question.
- Maximizing the sponsor's value for the resources expended.
- Providing data handling and reporting techniques appropriate for the data collected.

Sponsor's Ethics

Occasionally, research specialists may be asked by the sponsors to participate in unethical behavior. Compliance by the researcher would be a breach of ethical standards. Some examples to be avoided are;

- Violating respondent confidentiality.
- Changing data or creating false data to meet the desired objective.
- Changing data presentation or interpretations.
- Interpreting data from a biased perspective.
- Omitting sections of data analysis and conclusions.
- Making recommendations beyond the scope of data collected.

Researchers and Team Members

Another ethical responsibility of researchers is their team's safety as well as their own. The responsibility for ethical behavior rests with the researcher who, along with assistants, is charged with protecting the anonymity of both the sponsor and the respondent.

Safety

It is the researcher's responsibility to design a project so the safety of all interviewers, surveyors, experimenters, or observers is protected. Several factors may be important to consider in ensuring a researcher's right to safety.

Ethical behavior of Assistants

Researchers should require ethical compliance from team members just as sponsors expect ethical behavior from researcher. Assistants are expected to carry out the sampling plan, to interview or observe respondents without bias, and to accurately record all necessary data.

Protection of Anonymity

Researchers and assistants should protect the confidentiality of the sponsor's information and anonymity of the respondents. Each researcher handling data should be required to sign a confidentiality and nondisclosure statement.

Professional Standards

Various standards of ethics exist for the professional researcher. Many corporations, professional associations, and universities have code of ethics. These codes of ethic have to be enforced.

Reliability and Validity

Reliability and validity are concepts used to evaluate the quality of research. They indicate how well a method, technique or test measures something. Reliability is about the consistency of a measure, and validity is about the accuracy of a measure. It's important to consider reliability and validity when you are creating your research design, planning your methods, and writing up your results, especially in quantitative research.

	Reliability	Validity
What does it tell you?	The extent to which the results can be reproduced when the research is repeated under the same conditions.	The extent to which the results really measure what they are supposed to measure.
How is it assessed?	By checking the consistency of results across time, across different observers, and across parts of the test itself.	By checking how well the results correspond to established theories and other measures of the same concept.
How do they relate?	A reliable measurement is not always valid: the results might be reproducible, but they're not necessarily correct.	A valid measurement is generally reliable: if a test produces accurate results, they should be reproducible.

What is reliability?

Reliability refers to how consistently a method measures something. If the same result can be consistently achieved by using the same methods under the same circumstances, the measurement is considered reliable. You measure the temperature of a liquid sample several times under identical conditions. The thermometer displays the same temperature every time, so the results are reliable. A doctor uses a symptom questionnaire to diagnose a patient with a long-term medical condition. Several different doctors use the same questionnaire with the same patient but give different diagnoses. This indicates that the questionnaire has low reliability as a measure of the condition.

Types of reliability

Different types of reliability can be estimated through various statistical methods.

Type of reliability	What does it assess?	Example
Test-retest	The consistency of a measure across time : do you get the same results when you repeat the measurement?	A group of participants complete a questionnaire designed to measure personality traits. If they repeat the questionnaire days, weeks or months apart and give the same answers, this indicates high test-retest reliability.
Interrater	The consistency of a measure across raters or observers : do you get the same results when different people conduct the same measurement?	Based on an assessment criteria checklist, five examiners submit substantially different results for the same student project. This indicates that the assessment checklist has low inter-rater reliability (for example, because the criteria are too subjective).
Internal consistency	The consistency of the measurement itself : do you get the same results from different parts of a test that are designed to measure the same thing?	You design a questionnaire to measure self-esteem. If you randomly split the results into two halves, there should be a strong correlation between the two sets of results. If the two results are very different, this indicates low internal consistency.

What is validity?

Validity refers to how accurately a method measures what it is intended to measure. If research has high validity, that means it produces results that correspond to real properties, characteristics, and variations in the physical or social world.

High reliability is one indicator that a measurement is valid. If a method is not reliable, it probably isn't valid. If the thermometer shows different temperatures each time, even though you have carefully controlled conditions to ensure the sample's temperature stays the same, the thermometer is probably malfunctioning, and therefore its measurements are not valid.

If a symptom questionnaire results in a reliable diagnosis when answered at different times and with different doctors, this indicates that it has high validity as a measurement of the medical condition. However, reliability on its own is not enough to ensure validity. Even if a test is reliable, it may not accurately reflect the real situation. The thermometer that you used to test the sample gives reliable results. However, the thermometer has not been calibrated properly, so the result is 2 degrees lower than the true value. Therefore, the measurement is not valid.

A group of participants take a test designed to measure working memory. The results are reliable, but participants' scores correlate strongly with their level of reading comprehension. This indicates that the method might have low validity: the test may be measuring participants' reading comprehension instead of their working memory.

Types of validity

The validity of a measurement can be estimated based on three main types of evidence. Each type can be evaluated through expert judgement or statistical methods.

Types of validity

Type of validity	What does it assess?	Example
Construct	The adherence of a measure to existing theory and knowledge of the concept being measured.	A self-esteem questionnaire could be assessed by measuring other traits known or assumed to be related to the concept of self-esteem (such as social skills and optimism). Strong correlation between the scores for self-esteem and associated traits would indicate high construct validity.
Content	The extent to which the measurement covers all aspects of the concept being measured.	A test that aims to measure a class of students' level of Spanish contains reading, writing and speaking components, but no listening component. Experts agree that listening comprehension is an essential aspect of language ability, so the test lacks content validity for measuring the overall level of ability in Spanish.
Criterion	The extent to which the result of a measure corresponds to other valid measures of the same concept.	A survey is conducted to measure the political opinions of voters in a region. If the results accurately predict the later outcome of an election in that region, this indicates that the survey has high criterion validity.

How are reliability and validity assessed?

Validity is harder to assess than reliability, but it is even more important. To obtain useful results, the methods you use to collect your data must be valid: the research must be measuring what it claims to measure. This ensures that your discussion of the data and the conclusions you draw are also valid. Reliability can be estimated by comparing different versions of the same measurement. Validity is harder to assess, but it can be estimated by comparing the results to other relevant data or theory. Methods of estimating reliability and validity are usually split up into different types.

How to ensure validity and reliability in your research

The reliability and validity of your results depends on creating a strong research design, choosing appropriate methods and samples, and conducting the research carefully and consistently.

Ensuring validity

If you use scores or ratings to measure variations in something (such as psychological traits, levels of ability or physical properties), it's important that your results reflect the real variations as accurately as possible. Validity should be considered in the very earliest stages of your research, when you decide how you will collect your data.

- **Choose appropriate methods of measurement**

Ensure that your method and measurement technique are high quality and targeted to measure exactly what you want to know. They should be thoroughly researched and based on existing knowledge.

For example, to collect data on a personality trait, you could use a standardized questionnaire that is considered reliable and valid. If you develop your own questionnaire, it should be based on established theory or findings of previous studies, and the questions should be carefully and precisely worded.

- Use appropriate sampling methods to select your subjects

To produce valid generalizable results, clearly define the population you are researching (e.g. people from a specific age range, geographical location, or profession). Ensure that you have enough participants and that they are representative of the population.

Ensuring reliability

Reliability should be considered throughout the data collection process. When you use a tool or technique to collect data, it's important that the results are precise, stable and reproducible.

- Apply your methods consistently

Plan your method carefully to make sure you carry out the same steps in the same way for each measurement. This is especially important if multiple researchers are involved.

For example, if you are conducting interviews or observations, clearly define how specific behaviours or responses will be counted, and make sure questions are phrased the same way each time.

- Standardize the conditions of your research

When you collect your data, keep the circumstances as consistent as possible to reduce the influence of external factors that might create variation in the results.

For example, in an experimental setup, make sure all participants are given the same information and tested under the same conditions.

Where to write about reliability and validity in a thesis

It's appropriate to discuss reliability and validity in various sections of your thesis or dissertation. Showing that you have taken them into account in planning your research and interpreting the results makes your work more credible and trustworthy.

Reliability and validity in a thesis

Section	Discuss
Literature review	What have other researchers done to devise and improve methods that are reliable and valid?
Methodology	How did you plan your research to ensure reliability and validity of the measures used? This includes the chosen sample set and size, sample preparation, external conditions and measuring techniques.
Results	If you calculate reliability and validity, state these values alongside your main results.
Discussion	This is the moment to talk about how reliable and valid your results actually were. Were they consistent, and did they reflect true values? If not, why not?
Conclusion	If reliability and validity were a big problem for your findings, it might be helpful to mention this here.

Lesson 27**DATA ANALYSIS AND INTERPRETATION TECHNIQUES****Topic 027: Data Analysis and Interpretation Techniques****Introduction**

Once the data begins to flow in, attention turns to data analysis. If the project has been done correctly, the analysis planning is already done. Back at the research design stage or at least by the completion of the proposal or the pilot test, decisions should have been made about how to analyze the data. During the analysis stage several interrelated procedures are performed to summarize and rearrange the data. The goal of most research is to provide information. There is a difference between raw data and information.

Information

Information refers to a body of facts that are in a format suitable for decision making, whereas data are simply recorded measures of certain phenomenon. The raw data collected in the field must be transformed into information that will answer the sponsor's (e.g. manager's) questions. The conversion of raw data into information requires that the data be edited and coded so that the data may be transferred to a computer or other data storage medium. If the database is large, there are many advantages to utilizing a computer. Assuming a large database, entering the data into computer follows the coding procedure

Editing

Editing is the process of checking and adjusting the data for omissions, legibility, and consistency. Editing may be differentiated from coding, which is the assignment of numerical scales or classifying symbols to previously edited data. The purpose of editing is to ensure the completeness, consistency, and readability of the data to be transferred to data storage. The editor's task is to check for errors and omissions on the questionnaires or other data collection forms. The editor may have to reconstruct some data. For instance, a respondent may indicate weekly income rather than monthly income, as requested on the questionnaire. The editor must convert the information to monthly data without adding any extraneous information. The editor "should bring to light all hidden values and extract all possible information from a questionnaire, while adding nothing extraneous."

Coding

Coding involves assigning numbers or other symbols to answers so the responses can be grouped into limited number of classes or categories. The classifying of data into limited categories sacrifices some data detail but is necessary for efficient analysis. Nevertheless, it is recommended that try to keep the data in raw form so far it is possible. When the data have been entered into the computer you can always ask the computer to group and regroup the categories. In case the data have been entered in the compute in grouped form, it will not be possible to disaggregate it. Although codes are generally considered to be numerical symbols, they are more broadly defined as the rules for interpreting, classifying, and recording data. Codes allow data to be processed in a computer. Researchers organize data into fields, records, and files. A field is a collection of characters (a character is a single number, letter of the alphabet, or special symbol such as the question mark) that represent a single type of data. A record is collection of related fields. A file is a collection of related records. File, records, and fields are stored on magnetic tapes, floppy disks, or hard drives. Researchers use a coding

procedure and codebook. A coding procedure is a set of rules stating that certain numbers are assigned to variable attributes.

For example, a researcher codes males as 1 and females as 2. Each category of variable and missing information needs a code. A codebook is a document (i.e. one or more pages) describing the coding procedure and the location of data for variables in a format that computers can use. When you code data, it is very important to create a well-organized, detailed codebook and make multiple copies of it. If you do not write down the details of the coding procedure, or if you misplace the codebook, you have lost the key to the data and may have to recode the data again. Researchers begin thinking about a coding procedure and a codebook before they collect data. For example a survey researcher pre-codes a questionnaire before collecting the data. Pre-coding means placing the code categories (e.g. 1 for male, 2 for female) on the questionnaire. Sometimes to reduce dependence on codebooks, researchers also place the location in the computer format on the questionnaire. If the researcher does not pre-code, his or her first step after collecting and editing of data is to create a codebook. He or she also gives each case an identification number to keep track of the cases. Next, the researcher transfers the information from each questionnaire into a format that computers can read.

Code Construction

When the question has a fixed-alternative (closed ended) format, the number of categories requiring codes is determined during the questionnaire design stage. The codes 8 and 9 are conventionally given to “don’t know” (DK) and “no answer” (NA) respectively. However, many computer program fields recognize a blank field or a certain character symbol, such as a period (.), as indicating a missing value (no answer). There are two basic rules for code construction. First, the coding categories should be exhaustive – that is, coding categories should be provided for all subjects or objects or responses. With a categorical variable such as sex, making categories exhaustive is not a problem. However, when the response represents a small number of subjects or when the responses might be categorized in a class not typically found, there may be a problem. Second, the coding categories should also be mutually exclusive and independent. This means that there should be no overlap between the categories, to ensure that a subject or response can be placed in only one category. This frequently requires that an “other” code category be included, so that the categories are all inclusive and mutually exclusive.

For example, managerial span of control might be coded 1, 2, 3, 4, and “5 or more.” The “5 or more” category ensures everyone a place in a category. When a questionnaire is highly structured, pre-coding of the categories typically occurs before the data are collected. In many cases, such as when researchers are using open-ended response questions, a framework for classifying responses to questions cannot be established before data collection. This situation requires some careful thought concerning the determination of categories after editing process has been completed. This is called post-coding or simply coding. The purpose of coding open-ended response questions is to reduce the large number of individual responses to a few general categories of answers that can be assigned numerical scores. Code construction in these situations necessarily must reflect the judgment of the researcher. A major objective in code-building process is to accurately transfer the meaning from written answers to numeric codes.

Code Book

A book identifying each variable in a study and its position in the data matrix is known as code book. The book is used to identify a variable’s description, code name, and field. Here is a sample:

<u>Q/V No.</u>	<u>Field/ col. No.</u>	<u>Code values</u>
--	1-5	Study number
-	6	City
		1 = Lahore
		2 = Rawalpindi
		3 = Karachi
	7 -9	Interview No.
Sex	10	1 = Male
		2 = Female
Age	11-12	Actual
Education	13	1 = Non literate
		2 = Literate

Production Coding

Transferring the data from the questionnaire or data collection form after the data have been collected is called production coding. Depending upon the nature of the data collection form, codes may be written directly on the instrument or on a special coding sheet.

Data Entries

Use of scanner sheets for data collection may facilitate the entry of the responses directly into the computer without manual keying in the data. In studies involving highly structured paper questionnaires, an Optical scanning system may be used to read material directly to the computers' memory into the computers' memory. Optical scanners process the marked-sensed questionnaires and store the answers in a file.

Cleaning Data

The final stage in the coding process is the error checking and verification, or "data cleaning" stage, which is a check to make sure that all codes are legitimate. Accuracy is extremely important when coding data. Errors made when coding or entering data into a computer threaten the validity of measures and cause misleading results. A researcher who has perfect sample, perfect measures, and no errors in gathering data, but who makes errors in the coding process or in entering data into a computer, can ruin a whole research project.

Types of Analysis

1. Univariate Analysis

Uni means one and variate means variable, so in univariate analysis, there is only one dependable variable. The objective of univariate analysis is to derive the data, define and summarize it, and analyze the pattern present in it. In a dataset, it explores each variable separately. It is possible for two kinds of variables- Categorical and Numerical.

Some patterns that can be easily identified with univariate analysis are Central Tendency (mean, mode and median), Dispersion (range, variance), Quartiles (interquartile range), and Standard deviation.

2. Bivariate Analysis

Bi means two and variate means variable, so here there are two variables. The analysis is related to cause and the relationship between the two variables. There are three types of bivariate analysis.

Bivariate Analysis of two Numerical Variables (Numerical-Numerical)

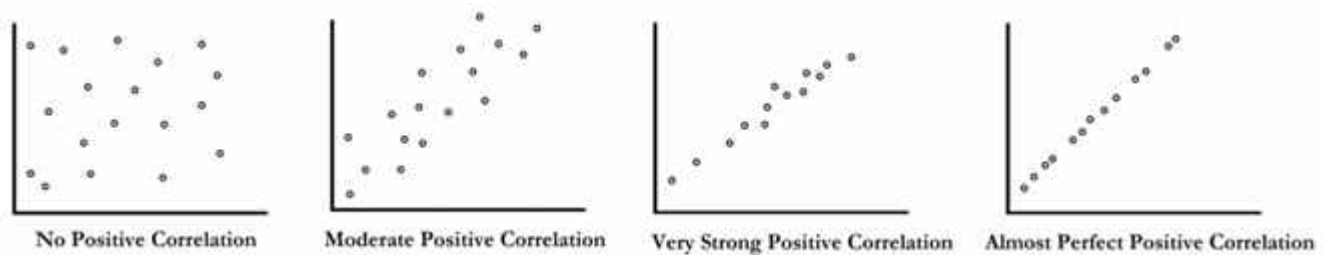
Scatter Plot

A scatter plot represents individual pieces of data using dots. These plots make it easier to see if two variables are related to each other. The resulting pattern indicates the type (linear or non-linear) and strength of the relationship between two variables.

Linear Correlation

Linear Correlation represents the strength of a linear relationship between two numerical variables. If there is no correlation between the two variables, there is no tendency to change along with the values of the second quantity.

Here, r measures the strength of a linear relationship and is always between -1 and 1 where -1 denotes perfect negative linear correlation and +1 denotes perfect positive linear correlation and zero denotes no linear correlation.



Bivariate Analysis of two categorical Variables (Categorical-Categorical)

Chi-square Test

The chi-square test is used for determining the association between categorical variables. It is calculated based on the difference between expected frequencies and the observed frequencies in one or more categories of the frequency table. A probability of zero indicates a complete dependency between two categorical variables and a probability of one indicates that two categorical variables are completely independent.

Here, subscript c indicates the degrees of freedom, O indicates observed value, and E indicates expected value.

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

Bivariate Analysis of one numerical and one categorical variable (Numerical-Categorical)

Z-test and t-test

Z and T-tests are important to calculate if the difference between a sample and population is substantial.

$$Z = \frac{\bar{X} - \mu}{\sigma / \sqrt{n}}$$

$\bar{x}$ = sample mean

μ = population mean

σ = population standard deviation

n = sample size

If the probability of Z is small, the difference between the two averages is more significant.

T-Test

$$t = \frac{\bar{x} - \mu}{s_{\bar{x}}} \quad \text{where} \quad s_{\bar{x}} = \frac{s}{\sqrt{n}}$$

where

μ = Proposed constant for the population mean

$\bar{x}$ = Sample mean

n = Sample size (i.e., number of observations)

s = Sample standard deviation

$s_{\bar{x}}$ = Estimated standard error of the mean ($s/\sqrt{n}$)

If the sample size is large enough, then we use a Z-test, and for a small sample size, we use a T-test.

ANALYSIS OF VARIANCE (ANOVA)

The ANOVA test is used to determine whether there is a significant difference among the averages of more than two groups that are statistically different from each other. This analysis is appropriate for comparing the averages of a numerical variable for more than two categories of a categorical variable.

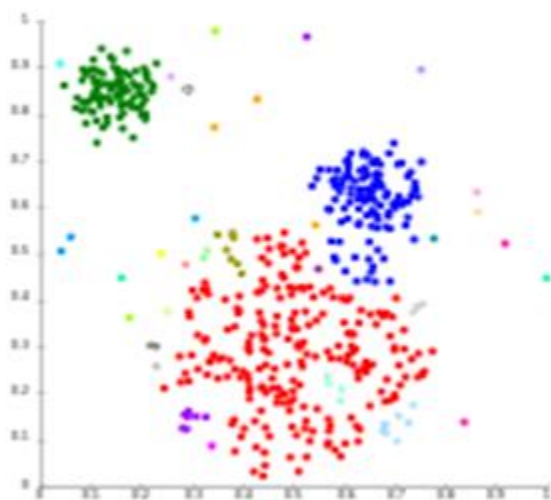
Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares (MS)	F
Within	$SSW = \sum_{j=1}^k \sum_{i=1}^l (X_{ij} - \bar{X}_j)^2$	$df_w = k - 1$	$MSW = \frac{SSW}{df_w}$	$F = \frac{MSB}{MSW}$
Between	$SSB = \sum_{j=1}^k (\bar{X}_j - \bar{X})^2$	$df_b = n - k$	$MSB = \frac{SSB}{df_b}$	
Total	$SST = \sum_{j=1}^n (\bar{X}_j - \bar{X})^2$	$df_t = n - 1$		

Multivariate Analysis

Multivariate analysis is required when more than two variables have to be analyzed simultaneously. It is a tremendously hard task for the human brain to visualize a relationship among 4 variables in a graph and thus multivariate analysis is used to study more complex sets of data. Types of Multivariate Analysis include Cluster Analysis, Factor Analysis, Multiple Regression Analysis, Principal Component Analysis, etc. More than 20 different ways to perform multivariate analysis exist and which one to choose depends upon the type of data and the end goal to achieve. The most common ways are:

Cluster Analysis

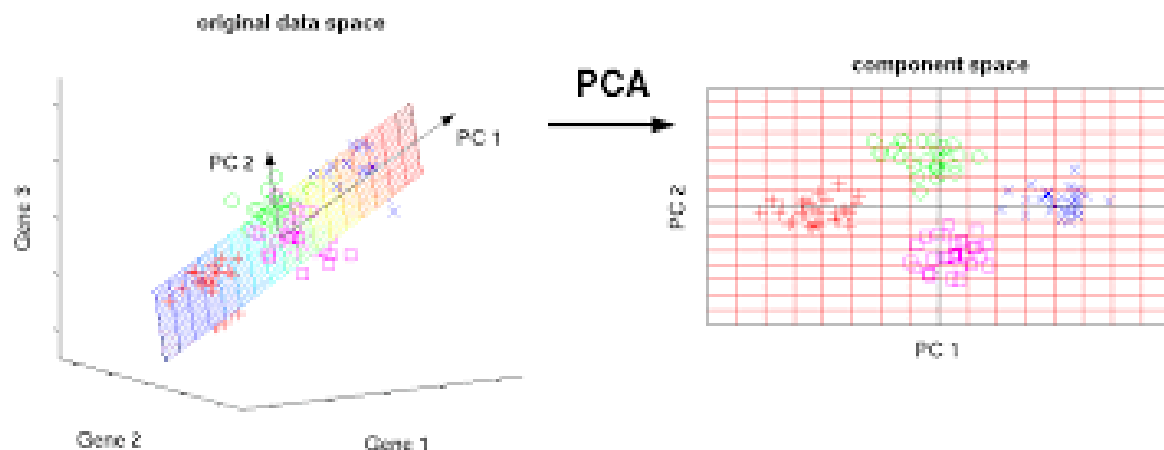
Cluster Analysis classifies different objects into clusters in a way that the similarity between two objects from the same group is maximum and minimal otherwise. It is used when rows and columns of the data table represent the same units and the measure represents distance or similarity.



Principal Component Analysis (PCA)

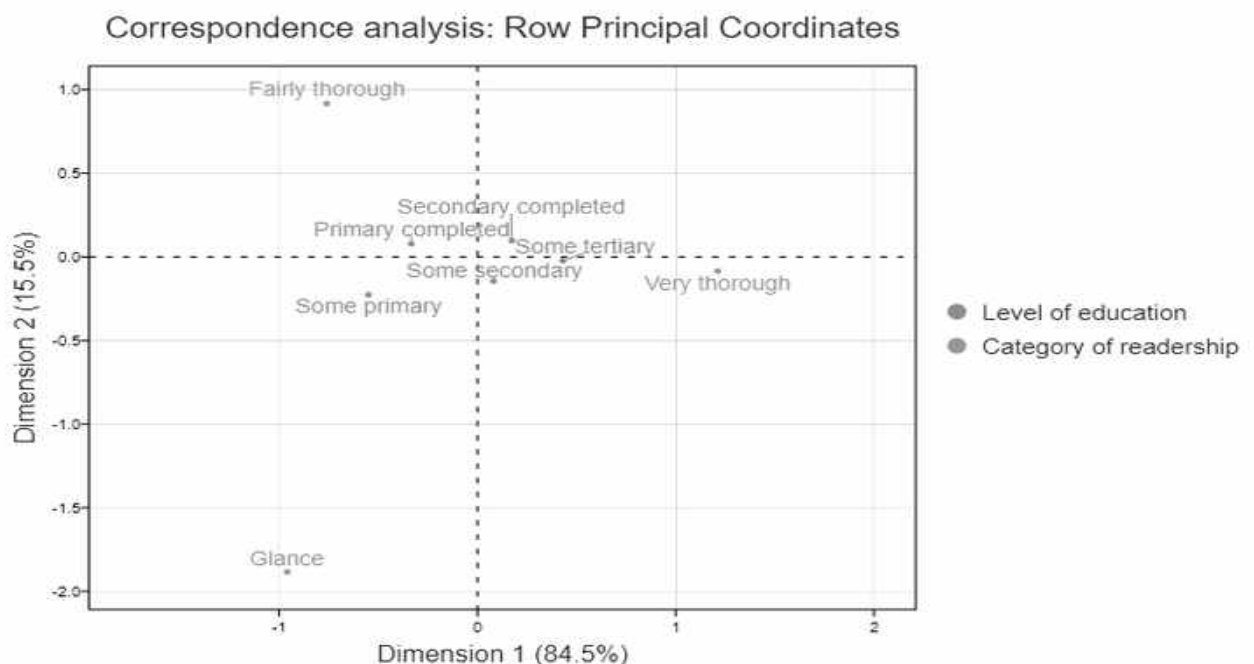
Principal Components Analysis (or PCA) is used for reducing the dimensionality of a data table with a large number of interrelated measures. Here, the original variables are converted into a new set of variables, which are known as the “Principal Components” of Principal Component Analysis.

PCA is used for the dataset that shows multicollinearity. Although least squares estimates are biased, the distance between variances and their actual value can be really large. So, PCA adds some bias and reduces standard error for the regression model.



Correspondence Analysis

Correspondence Analysis using the data from a contingency table shows relative relationships between and among two different groups of variables. A contingency table is a 2D table with rows and columns as groups of variables.



Quantitative Analysis

Quantitative data analysis simply means analysing data that is numbers-based – or data that can be easily “converted” into numbers without losing any meaning. For example, category-based variables like gender, ethnicity, or native language could all be “converted” into numbers without losing meaning – for example, English could equal 1, French 2, etc.

What is quantitative analysis used for?

Quantitative analysis is generally used for three purposes.

- Firstly, it’s used to measure **differences between groups**. For example, the popularity of different clothing colours or brands.
- Secondly, it’s used to assess **relationships between variables**. For example, the relationship between weather temperature and voter turnout.
- And third, it’s used to **test hypotheses** in a scientifically rigorous way. For example, a hypothesis about the impact of a certain vaccine.

Branches” of quantitative analysis

Quantitative analysis is powered by **statistical analysis methods**. There are two main “branches” of statistical methods that are used – **descriptive** statistics and **inferential** statistics. In your research, you might **only** use descriptive statistics, or you might use a **mix of both**, depending on what you’re trying to figure out. In other words, depending on your research questions, aims and objectives.

1. Descriptive Statistics

Descriptive statistics serve a simple but critically important role in your research – to **describe** your data set – hence the name. In other words, they help you understand the details of your **sample**. Unlike inferential statistics (which we’ll get to soon), descriptive statistics don’t aim to make **inferences** or predictions about the entire population – they’re purely interested in the details of **your specific sample**.

When you’re writing up your analysis, descriptive statistics are the first set of stats you’ll cover, before moving on to inferential statistics. But, that said, depending on your research objectives and research questions, they may be the only type of statistics you use. We’ll explore that a little later.

What kind of statistics are usually covered in this section?

Some common statistical tests used in this branch include the following:

- **Mean** – this is simply the mathematical average of a range of numbers.
- **Median** – this is the midpoint in a range of numbers when the numbers are arranged in numerical order. If the data set makes up an odd number, then the median is the number right in the middle of the set. If the data set makes up an even number, then the median is the midpoint between the two middle numbers.

- **Mode** – this is simply the most commonly occurring number in the data set.
- **Standard deviation** – this metric indicates how dispersed a range of numbers is. In other words, how close all the numbers are to the mean (the average).
 - In cases where most of the numbers are quite close to the average, the standard deviation will be relatively low.
 - Conversely, in cases where the numbers are scattered all over the place, the standard deviation will be relatively high.
- **Skewness**. As the name suggests, skewness indicates how symmetrical a range of numbers is. In other words, do they tend to cluster into a smooth bell curve shape in the middle of the graph, or do they skew to the left or right?

Feeling a bit confused? Let's look at a practical example using a small data set.

Data set		Descriptive statistics		
Person	Weight (kg)	Statistic	Result	Formula
1	70	Mean (average)	72.4	=AVERAGE
2	55	Median	74	=MEDIAN
3	90	Standard Deviation	10.637	=STDEV.S
4	75	Variance	113.15556	=VAR.S
5	66	Skewness	-0.223701	=SKEW
6	73			
7	80			
8	58			
9	76			
10	81			

On the left-hand side is the data set. This details the bodyweight of a sample of 10 people. On the right-hand side, we have the descriptive statistics. Let's take a look at each of them.

First, we can see that the **mean weight** is 72.4 kilograms. In other words, the average weight across the sample is 72.4 kilograms. Straightforward.

Next, we can see that the **median** is very similar to the mean (the average). This suggests that this data set has a reasonably symmetrical distribution (in other words, a relatively smooth, centred distribution of weights, clustered towards the centre).

In terms of the **mode**, there is no mode in this data set. This is because each number is present only once and so there cannot be a “most common number”. If there were two people who were both 65 kilograms, for example, then the mode would be 65.

Next up is the **standard deviation**. 10.6 indicates that there’s quite a wide spread of numbers. We can see this quite easily by looking at the numbers themselves, which range from 55 to 90, which is quite a stretch from the mean of 72.4.

And lastly, the **skewness** of -0.2 tells us that the data is very slightly negatively skewed. This makes sense since the mean and the median are slightly different.

As you can see, these descriptive statistics give us some **useful insight** into the data set. Of course, this is a **very small** data set (only 10 records), so we can’t read into these statistics too much. Also, keep in mind that this is not a list of all possible descriptive statistics – just the most common ones.

But why do all of these numbers matter?

While these descriptive statistics are all fairly basic, they’re important for a few reasons:

- Firstly, they help you get both a **macro and micro-level view** of your data. In other words, they help you understand both the big picture and the finer details.
- Secondly, they help you **spot potential errors** in the data – for example, if an average is way higher than you’d expect, or responses to a question are highly varied, this can act as a warning sign that you need to double-check the data.
- And lastly, these descriptive statistics help **inform which inferential statistical techniques** you can use, as those techniques depend on the skewness (in other words, the symmetry and normality) of the data.

Simply put, **descriptive statistics are really important**, even though the statistical techniques used are fairly basic. All too often at Grad Coach, we see students skimming over the descriptives in their eagerness to get to the more exciting inferential methods, and then landing up with some very flawed results.

2. Inferential Statistics

As I mentioned, while **descriptive statistics** are all about the details of your specific data set – your **sample** – **inferential statistics** aim to make inferences about the **population**. In other words, you’ll use inferential statistics to make **predictions** about what you’d expect to find in the full population.

What kind of predictions, you ask?

There are two common types of predictions that researchers try to make using inferential stats:

- Firstly, predictions about **differences between groups** – for example, height differences between children grouped by their favourite meal or gender.
- And secondly, **relationships between variables** – for example, the relationship between body weight and the number of hours a week a person does yoga.

In other words, inferential statistics (when done correctly), allow you to connect the dots and **make predictions** about what you expect to see in the real world population, based on what you observe in your sample data. For this reason, inferential statistics are used for **hypothesis testing** – in other words, to test hypotheses that predict changes or differences.

Of course, when you're working with inferential statistics, the **composition of your sample** is really important. In other words, if your sample doesn't accurately represent the population you're researching, then your findings won't necessarily be very useful.

For example, if your population of interest is a mix of **50% male** and **50% female**, but your sample is **80% male**, you can't make inferences about the population based on your sample, since it's not representative. This area of statistics is called sampling, but we won't go down that rabbit hole here (it's a deep one!) – we'll save that for another post.

What statistics are usually used in this branch?

There are many, many different statistical analysis methods within the inferential branch and it'd be impossible for us to discuss them all here. So we'll just take a look at some of the most common inferential statistical methods so that you have a solid starting point.

1. **T-Tests.** T-tests **compare the means** (the averages) of two groups of data to assess whether they're statistically significantly different. In other words, do they have significantly different means, standard deviations and skewness. This type of testing is very useful for understanding just how similar or different two groups of data are. For example, you might want to compare the mean blood pressure between two groups of people – one that has taken a new medication and one that hasn't – to assess whether they are significantly different.
2. **ANOVA**, which stands for “analysis of variance”. This test is similar to a T-test in that it compares the means of various groups, but ANOVA allows you to analyse **multiple groups**, not just two groups So it's basically a t-test on steroids...
3. **Correlation analysis.** This type of analysis assesses the relationship between two variables. In other words, if one variable increases, does the other variable also increase, decrease or stay the same. For example, if the average temperature goes up, do average ice creams sales increase too? We'd expect some sort of relationship between these two variables **intuitively**, but correlation analysis allows us to measure that relationship **scientifically**.
4. **regression analysis** – this is quite similar to correlation in that it assesses the relationship between variables, but it goes a step further to understand **cause and effect** between variables, not just whether they move together. In other words, does the one variable actually cause the other one to move, or do they just happen to move together naturally thanks to another force? Just because two variables correlate doesn't necessarily mean that one causes the other.

How to Correct Data Analysis Method

How to choose the right analysis method

To choose the right statistical methods, you need to think about **two important factors**:

1. The **type** of quantitative data you have (specifically, **level of measurement** and the shape of the data). And,
2. Your **research questions and hypotheses**

Factor 1 – Data type

The first thing you need to consider is the **type** of data you've collected (or the type of data you **will** collect). By data types, I'm referring to the **four levels of measurement** – namely, nominal, ordinal, interval and ratio. If you're not familiar with this lingo, [check out this post](#) which explains each of the four levels of measurement.

	Nominal	Ordinal	Interval	Ratio
Categories	✓	✓	✓	✓
Order/rank		✓	✓	✓
Equal spacing			✓	✓
True absolute zero				✓
Can add and subtract			✓	✓
Can multiply and divide				✓
Can calculate mode	✓	✓	✓	✓
Can calculate median		✓	✓	✓
Can calculate arithmetic mean			✓	✓
Can calculate geometric mean				✓

Why does this matter?

Different statistical methods and techniques **require** different types of data. This is one of the “assumptions” I mentioned earlier – every method has its assumptions regarding the type of data. For example, some techniques work with **categorical** data (for example, yes/no type questions, or gender or ethnicity), while others work with **continuous numerical** data (for example, age, weight or income) – and, of course, some work with multiple data types. If you try to use a statistical method that doesn't support the data type you have, your results will be largely meaningless. So, make sure that you have a clear understanding of what types of data you've collected (or will collect). Once you have this, you can then check which statistical methods would support your data types here. If you haven't collected your data yet, you can work in reverse and look at which statistical method would give you the most useful insights, and then design your data collection strategy to collect the correct data types. Another important factor to consider is the **shape of your data**. Specifically, does it have a **normal distribution** (in other words, is it a bell-shaped curve, centred in the middle) or is it very **skewed** to the left or the right? Again, different statistical techniques work for different shapes of data – some are designed for symmetrical data while others are designed for skewed data.

Factor 2: Your research questions

The next thing you need to consider is your specific **research questions**, as well as your **hypotheses** (if you have some). The nature of your research questions and research hypotheses will heavily influence which statistical methods and techniques you should use.

If you're just interested in understanding the attributes of your **sample** (as opposed to the entire population), then **descriptive statistics** are probably all you need. For example, if you just want to assess the means (averages) and medians (centre points) of variables in a group of people.

On the other hand, if you aim to understand **differences between groups** or **relationships between variables** and to infer or predict outcomes in the population, then you'll likely need both descriptive statistics **and** inferential statistics.

So, it's really important to get very clear about your research aims and research questions, as well your hypotheses – before you start looking at which statistical techniques to use.

Conclusion

1. Quantitative data analysis is all about **analysing number-based data** (which includes categorical and numerical data) using various statistical techniques.
2. The two main **branches** of statistics are **descriptive statistics** and **inferential statistics**. Descriptives describe your sample, whereas inferentials make predictions about what you'll find in the population.
3. Common **descriptive statistical methods** include **mean** (average), **median**, standard **deviation** and **skewness**.
4. Common **inferential statistical methods** include **t-tests**, **ANOVA**, **correlation** and **regression** analysis.
5. To choose the right statistical methods and techniques, you need to consider the **type of data you're working with**, as well as your **research questions** and hypotheses.

Lesson 28**CORRELATION****Topic 028: Correlation****Introduction**

Correlation first developed by Sir Francis Galton (1822 – 1911) and then reformulated by Karl Pearson (1857 – 1936). Two variables are said to be correlated if the change in one variable results in a corresponding change in the other variable. The correlation is a statistical tool which studies the relationship between two variables. Correlation analysis involves various methods and techniques used for studying and measuring the extent of the relationship between the two variables. Correlation is concerned with the measurement of “strength of association between variables”. The degree of association between two or more variables is termed as correlation. Correlation analysis helps us to decide the strength of the linear relationship between two variables. The word correlation is used to decide the degree of association between variables. If two variables ‘x’ and ‘y’ are so related, the variables in the magnitude of one variable tend to be accompanied by variations in the magnitude of the other variable, they are said to be correlated. Thus, correlation is a statistical tool, with the help of which, we can determine whether or not two or more variables are correlate and if they are correlated, what is the degree and direction of correlation.

Definition

The correlation is the measure of the extent and the direction of the relationship between two variables in a bivariate distribution.

Example:

- (i) Height and weight of children.
- (ii) An increase in the price of the commodity by a decrease in the quantity demanded.

Types of Correlation:

The following are the types of correlation

1. Positive and Negative Correlation
2. Simple, Partial and Multiple Correlation
3. Linear and Non-linear Correlation.

1. Positive and Negative correlation

If both the variables are varying in the same direction i.e. if one variable is increasing and the other on an average is also increasing or if as one variable is decreasing, the other on an average, is also decreasing, correlation is said to be positive. If on the other hand, the variable is increasing, the other is decreasing or vice versa, correlation is said to be negative.

Example 1: a) heights and weights (b) amount of rainfall and yields of crops (c) price and supply of a commodity (d) income and expenditure on luxury goods (e) blood pressure and age

Example 2: a) price and demand of commodity (b) sales of woolen garments and the day’s temperature.

2. Simple, Partial and Multiple Correlation

When only two variables are studied, it is a case of simple correlation. In partial and multiple correlation, three or more variables are studied. In multiple correlation three or more variables are studied simultaneously. In partial correlation, we have more than two variables, but

consider only two variables to be influencing each other, the effect of the other variables being kept constant.

3. Linear and Non-linear Correlation:

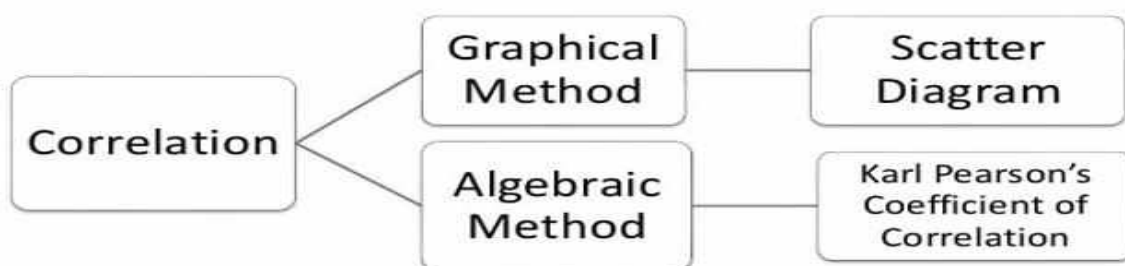
If the change in one variable tends to bear a constant ratio to the change in the other variable, the correlation is said to be linear. Correlation is said to be non-linear if the amount of change in one variable does not bear a constant ratio to the amount of change in the other variable.

Methods of Studying Correlation

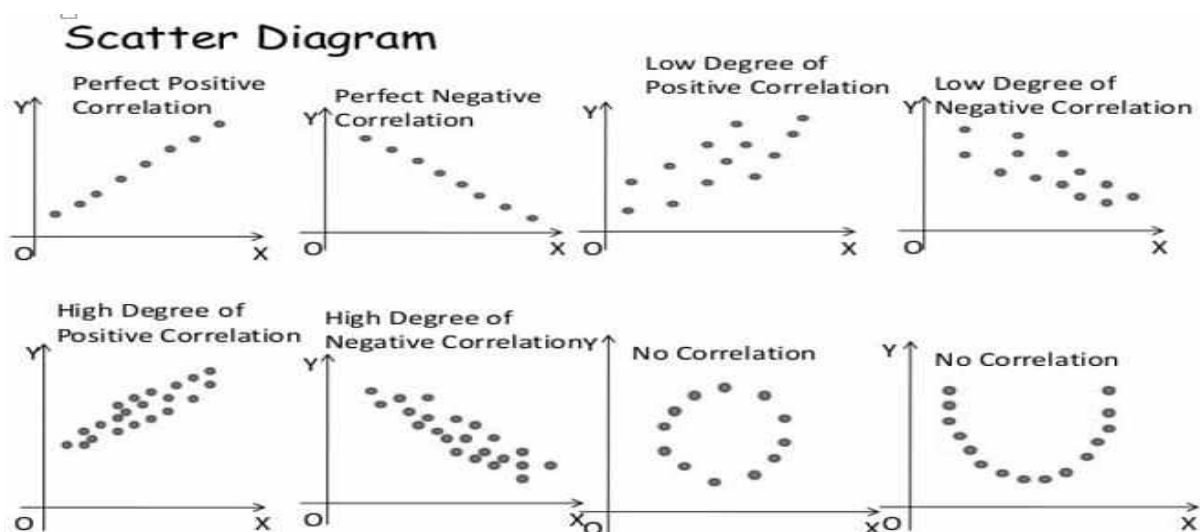
The following are the methods of determining correlation

1. Scatter diagram method
2. Karl Pearson's Coefficient of Correlation

Methods of Studying Correlation



1. Scatter Diagram: This is a graphic method of finding out relationship between the variables. Given data are plotted on a graph paper in the form of dots i.e. for each pair of x and y values we put a dot and thus obtain as many points as the number of observations. The greater the scatter of points over the graph, the lesser the relationship between the variables.



Interpretation

- If all the points lie in a straight line, there is either perfect positive or perfect negative correlation.
- If all the points lie on a straight falling from the lower left hand corner to the upper right hand corner then the correlation is perfect positive.
- Perfect positive if $r = +1$.
- If all the points lie on a straight falling from the upper left hand corner to the lower right hand corner then the correlation is perfect negative.
- Perfect negative if $r = -1$.
- The nearer the points are to be straight line, the higher degree of correlation.
- The farthest the points from the straight line, the lower degree of correlation.
- If the points are widely scattered and no trend is revealed, the variables may be uncorrelated i.e. $r = 0$.

2. The Coefficient of Correlation

A scatter diagram give an idea about the type of relationship or association between the variables under study. It does not tell us about the quantification of the association between the two. In order to quantify the relationship between the variables a measure called correlation coefficient developed by Karl Pearson. It is defined as the measure of the degree to which there is linear association between two intervally scaled variables. Thus, the coefficient of correlation is a number which indicates to what extent two variables are related, to what extent variations in one go with the variations in the other.

Interpretation

- i. If the covariance is positive, the relationship is positive.
- ii. If the covariance is negative, the relationship is negative.
- iii. If the covariance is zero, the variables are said to be not correlated.

Hence the covariance measures the strength of linear association between considered numerical variables. Thus, covariance is an absolute measure of linear association. In order to have relative measure of relationship it is necessary to compute correlation coefficient.

Lesson 29T-TEST AND ANOVATopic 029: T-test and ANOVA**Introduction**

A t-test is a statistical test that is used to compare the means of two groups. It is often used in hypothesis testing to determine whether a process or treatment actually has an effect on the population of interest, or whether two groups are different from one another. You want to know whether the mean petal length of iris flowers differs according to their species. You find two different species of irises growing in a garden and measure 25 petals of each species. You can test the difference between these two groups using a t-test.

- The null hypothesis (H_0) is that the true difference between these group means is zero.
- The alternate hypothesis (H_a) is that the true difference is different from zero.

When to use a t-test

A t-test can only be used when comparing the means of two groups (a.k.a. pairwise comparison). If you want to compare more than two groups, or if you want to do multiple pairwise comparisons, use an ANOVA test or a post-hoc test.

The t-test is a parametric test of difference, meaning that it makes the same assumptions about your data as other parametric tests. The t-test assumes your data:

1. are independent
2. are (approximately) normally distributed.
3. have a similar amount of variance within each group being compared (a.k.a. homogeneity of variance)

If your data do not fit these assumptions, you can try a nonparametric alternative to the t-test, such as the Wilcoxon Signed-Rank test for data with unequal variances.

What type of t-test should I use?

When choosing a t-test, you will need to consider two things: whether the groups being compared come from a single population or two different populations, and whether you want to test the difference in a specific direction.

One-sample, two-sample, or paired t-test?

- If the groups come from a single population (e.g. measuring before and after an experimental treatment), perform a **paired t-test**.
- If the groups come from two different populations (e.g. two different species, or people from two separate cities), perform a **two-sample t-test** (a.k.a. **independent t-test**).
- If there is one group being compared against a standard value (e.g. comparing the acidity of a liquid to a neutral pH of 7), perform a **one-sample t-test**.

One-tailed or two-tailed t-test?

- If you only care whether the two populations are different from one another, perform a **two-tailed t-test**.
- If you want to know whether one population mean is greater than or less than the other, perform a **one-tailed t-test**.

In your test of whether petal length differs by species:

- Your observations come from two separate populations (separate species), so you perform a two-sample t-test.
- You don't care about the direction of the difference, only whether there is a difference, so you choose to use a two-tailed t- test.

Performing a t-test

The t-test estimates the true difference between two group means using the ratio of the difference in group means over the pooled standard error of both groups. You can calculate it manually using a formula, or use statistical analysis software.

T-test formula

The formula for the two-sample t-test (a.k.a. the Student's t-test) is shown below.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

In this formula, t is the t-value, x_1 and x_2 are the means of the two groups being compared, s_2 is the pooled standard error of the two groups, and n_1 and n_2 are the number of observations in each of the groups.

A larger t -value shows that the difference between group means is greater than the pooled standard error, indicating a more significant difference between the groups.

You can compare your calculated t -value against the values in a critical value chart to determine whether your t -value is greater than what would be expected by chance. If so, you can reject the null hypothesis and conclude that the two groups are in fact different.

T-test function in statistical software

Most statistical software (R, SPSS, etc.) includes a t-test function. This built-in function will take your raw data and calculate the t -value. It will then compare it to the critical value, and calculate a p -value. This way you can quickly see whether your groups are statistically different.

An introduction to ANOVA

A statistical method for testing whether two or more dependent variable means are equal (i.e., the probability that any differences in means across several groups are due solely to sampling error). ANOVA, which stands for Analysis of Variance, is a statistical test used to analyze the difference between the means of more than two groups.

Variables in ANOVA (Analysis of Variance):

- ✓ Dependent variable is metric.
- ✓ Independent variable(s) is nominal with two or more levels – also called treatment, manipulation, or factor.

Types of ANOVA

- One-way ANOVA: only one independent variable with two or more levels.
- Two-way ANOVA: two independent variables each with two or more levels.
- With ANOVA, a single metric dependent variable is tested as the outcome of a treatment or manipulation.
- With MANOVA (Multiple Analysis of Variance), two or more metric dependent variables are tested as the outcome of a treatment(s).

One Way ANOVA

A one-way ANOVA uses one independent variable, while a two-way ANOVA uses two independent variables. Example: As a crop researcher, you want to test the effect of three different fertilizer mixtures on crop yield. You can use a one-way ANOVA to find out if there is a difference in crop yields between the three groups.

When to use a one-way ANOVA

Use a one-way ANOVA when you have collected data about one categorical independent variable and one quantitative dependent variable. The independent variable should have at least three levels (i.e. at least three different groups or categories).

ANOVA tells you if the dependent variable changes according to the level of the independent variable. For example:

- Your independent variable is social media use, and you assign groups to low, medium, and high levels of social media use to find out if there is a difference in hours of sleep per night.
- Your independent variable is brand of soda, and you collect data on Coke, Pepsi, Sprite, and Fanta to find out if there is a difference in the price per 100ml.
- Your independent variable is type of fertilizer, and you treat crop fields with mixtures 1, 2 and 3 to find out if there is a difference in crop yield.

The null hypothesis (H_0) of ANOVA is that there is no difference among group means. The alternate hypothesis (H_a) is that at least one group differs significantly from the overall mean of the dependent variable.

If you only want to compare two groups, use a t-test instead.

How does an ANOVA test work?

ANOVA determines whether the groups created by the levels of the independent variable are statistically different by calculating whether the means of the treatment levels are different from the overall mean of the dependent variable.

If any of the group means is significantly different from the overall mean, then the null hypothesis is rejected.

ANOVA uses the F-test for statistical significance. This allows for comparison of multiple means at once, because the error is calculated for the whole set of comparisons rather than for each individual two-way comparison (which would happen with a t-test).

The F-test compares the variance in each group mean from the overall group variance. If the variance within groups is smaller than the variance between groups, the F-test will find a higher

F-value, and therefore a higher likelihood that the difference observed is real and not due to chance.

Assumptions of ANOVA

The assumptions of the ANOVA test are the same as the general assumptions for any parametric test:

1. **Independence of observations:** the data were collected using statistically-valid methods, and there are no hidden relationships among observations. If your data fail to meet this assumption because you have a confounding variable that you need to control for statistically, use an ANOVA with blocking variables.
2. **Normally-distributed response variable:** The values of the dependent variable follow a normal distribution.
3. **Homogeneity of variance:** The variation within each group being compared is similar for every group. If the variances are different among the groups, then ANOVA probably isn't the right fit for the data.

An introduction to the two-way ANOVA

ANOVA (Analysis of Variance) is a statistical test used to analyze the difference between the means of more than two groups. A two-way ANOVA is used to estimate how the mean of a quantitative variable changes according to the levels of two categorical variables. Use a two-way ANOVA when you want to know how two independent variables, in combination, affect a dependent variable.

Example: You are researching which type of fertilizer and planting density produces the greatest crop yield in a field experiment. You assign different plots in a field to a combination of fertilizer type (1, 2, or 3) and planting density (1=low density, 2=high density), and measure the final crop yield in bushels per acre at harvest time.

You can use a two-way ANOVA to find out if fertilizer type and planting density have an effect on average crop yield.

When to use a two-way ANOVA

You can use a two-way ANOVA when you have collected data on a quantitative dependent variable at multiple levels of two categorical independent variables.

A **quantitative variable** represents amounts or counts of things. It can be divided to find a group mean.

Bushels per acre is a quantitative variable because it represents the amount of crop produced. It can be divided to find the average bushels per acre.

A **categorical variable** represents types or categories of things. A level is an individual category within the categorical variable.

Fertilizer types 1, 2, and 3 are levels within the categorical variable **fertilizer type**. Planting densities 1 and 2 are levels within the categorical variable **planting density**.

You should have enough observations in your data set to be able to find the mean of the quantitative dependent variable at each combination of levels of the independent variables.

Both of your independent variables should be categorical. If one of your independent variables is categorical and one is quantitative, use an ANCOVA instead.

How does the ANOVA test work?

ANOVA tests for significance using the F-test for statistical significance. The F-test is a groupwise comparison test, which means it compares the variance in each group mean to the overall variance in the dependent variable.

If the variance within groups is smaller than the variance between groups, the F-test will find a higher F-value, and therefore a higher likelihood that the difference observed is real and not due to chance.

A two-way ANOVA with interaction tests three null hypotheses at the same time:

- There is no difference in group means at any level of the first independent variable.
- There is no difference in group means at any level of the second independent variable.
- The effect of one independent variable does not depend on the effect of the other independent variable (a.k.a. no interaction effect).

A two-way ANOVA without interaction (a.k.a. an additive two-way ANOVA) only tests the first two of these hypotheses.

Two-way ANOVA hypotheses

In our crop yield experiment, we can test three hypotheses using two-way ANOVA:

Null hypothesis (H_0)	Alternate hypothesis (H_a)
There is no difference in average yield for any fertilizer type.	There is a difference in average yield by fertilizer type.
There is no difference in average yield at either planting density.	There is a difference in average yield by planting density.
The effect of one independent variable on average yield does not depend on the effect of the other independent variable (a.k.a. no interaction effect).	There is an interaction effect between planting density and fertilizer type on average yield.

Assumptions of the two-way ANOVA

To use a two-way ANOVA your data should meet certain assumptions. Two-way ANOVA makes all of the normal assumptions of a parametric test of difference:

1. Homogeneity of variance (a.k.a. homoscedasticity)

The variation around the mean for each group being compared should be similar among all groups. If your data don't meet this assumption, you may be able to use a non-parametric alternative, like the Kruskal-Wallis test.

2. Independence of observations

Your independent variables should not be dependent on one another (i.e. one should not cause the other). This is impossible to test with categorical variables – it can only be ensured by good experimental design.

In addition, your dependent variable should represent unique observations – that is, your observations should not be grouped within locations or individuals.

If your data don't meet this assumption (i.e. if you set up experimental treatments within blocks), you can include a blocking variable and/or use a repeated-measures ANOVA.

3. Normally-distributed dependent variable

The values of the dependent variable should follow a bell curve. If your data don't meet this assumption, you can try a data transformation.

In the crop-yield example, the response variable is normally distributed, and we can check for homoscedasticity after running the model. The experimental treatments were set up within blocks in the field, with four blocks each containing every possible combination of fertilizer type and planting density, so we should include this as a blocking variable in the model.

Lesson 30CROSSTAB AND CHI-SQUARETopic 030: Crosstab and Chi-square**Introduction**

Crosstabulation is a statistical technique used to display a breakdown of the data by these two variables (that is, it is a table that has displays the frequency of different majors broken down by gender).

The **Pearson chi-square test** essentially tells us whether the results of a crosstab are statistically significant. That is, are the two categorical variables **independent** (unrelated) of one another. So basically, the chi square test is a correlation test for categorical variables. So for our example, the chi-square test will tell us whether there are more female psychology majors than you would expect by chance (based on total number of males and females and total number of people in different majors).

When do we use these methods?

- When we have categorical variables
 - Do the percentages match up with how we thought they would?
 - Are two (or more) categorical variables independent?
- Can do it with continuous variables if you convert them into categories (we won't cover this), but you typically don't want to do this because you lose a lot of information, and these tests are not as "powerful" as parametric tests

Crosstabulation**Example**

Suppose that you are interested in whether there is a relationship between gender and educational level (undergraduate vs. graduate students) at ISU (year 2002). That is, are men and women equally likely to pursue a graduate education relative to an undergraduate education.

Setup our data in a "cross tabulation" of our two variables. The data are observed frequencies (f_o).

		Student level	
		Undergraduate	Graduate
Sex	Male	7,715	938
	Female	10,780	1,625

The next step in the crosstabulation procedure is to compute the **marginals** for the rows and columns. This simply means add the frequencies across the rows and down the columns.

		Student level		
		Undergraduate	Graduate	Row Marginals
Sex	Male	7,715	938	8,653
	Female	10,780	1,625	12,405
Column marginals		18,495	2,563	

So what can we tell from this table?

Overall there are more graduate students than undergraduates, and there are more female than male students at ISU.

However this doesn't answer our question about whether women are more or less likely (i.e. that there is a relationship) to pursue graduate school than men. To find this out we need to do an inferential test, the Chi-square.

Hypothesis Testing with Chi-squared

- We test the null hypothesis that nothing interesting is happening (i.e., there is no relationship) versus alternative hypothesis that findings are interesting (i.e., there is a relationship).
- The null hypothesis can only be rejected if there is a .05 or lower probability that our findings are due to chance. Hypothesis tests determine the extent to which our findings may be due to chance.
- A chi-square will be significant if the residuals (the differences between observed frequencies and expected frequencies) for one level of a variable differ as a function of another variable.
- The chi-square value does not tell us the nature of the differences.

The Chi-Square Formula

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

Example

A manufacturer of watches takes a sample of 200 people. Each person is classified by age and watch type preference (digital vs. analog). The question: is there a relationship between age and watch preference?

Setup our data in a "cross tabulation" of our two variables. The data are observed frequencies (f_o).

		Watch preference		
		digital	analog	undecided
Age	under 30	90	40	10
	over 30	10	40	10

Step 1: State the hypotheses and select an alpha level

H₀: Preference is independent of age
 H_a: Preference is related to age
 We'll set $\alpha = 0.05$

Step 2:

- Compute your degrees of freedom

$$df = (\#Columns - 1) * (\#Rows - 1)$$

- Go to Chi-square statistic table and find the critical value

For this example, with $df = 2$, and $\alpha = 0.05$ the critical chi-squared value is 5.99

Step 3: Collect your data and compute your test statistic

Part 1: Obtain row and column totals, also called the *marginals* (in blue).

		Watch preference			
		digital	analog	undecided	
Age	under 30	90	40	10	140
	over 30	10	40	10	60
		100	80	20	

Part 2: Compute the *expected frequencies*

$$f_e = \frac{f_{column} f_{row}}{n}$$

For people under 30

- preferring digital watches: $f_e = (100*140)/200 = 70$
- preferring analog watches: $f_e = (80*140)/200 = 56$
- undecided watches: $f_e = (20*140)/200 = 14$

For people over 30

- preferring digital watches: $f_e = (100*60)/200 = 30$
- preferring analog watches: $f_e = (80*60)/200 = 24$
- undecided watches: $f_e = (20*60)/200 = 6$

So let's enter the predicted (expected) values (in **green**) into our crosstabulation.

		Watch preference			
		digital	analog	undecided	
Age	under 30	90 70	40 56	10 14	140
	over 30	10 30	40 24	10 6	60
		100	80	20	

Part 3: Compute the Chi-squared statistic

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

- Find the residuals ($f_o - f_e$) for each cell
- Square these differences
- Divide the squared differences by f_e
- Sum the results

Cell	f_o	f_e	$(f_o - f_e)$	$(f_o - f_e)^2$	$(f_o - f_e)^2 / f_e$
<30 digital	90	70	20	400	5.71
<30 analog	40	56	-16	256	4.57
<30 undecided	10	14	-4	16	1.14
>30 digital	10	30	-20	400	13.33
>30 analog	40	24	16	256	10.67
>30 undecided	10	6	4	16	2.67

So then add them up

$$\chi^2 = 5.71 + 4.57 + 1.14 + 13.33 + 10.67 + 2.67 = 38.09$$

Step 4: Compare this computed statistic (38.09) against the critical value (5.99) and make a decision about your hypotheses

$$\chi^2(2, n = 200) = 38.09, p < 0.05$$

- Here we reject the H_0 and conclude that there is a relationship between age and watch preference.

Important Characteristics of A Chi Square Test

- This test (as a non-parametric test) is based on frequencies and not on the parameters like mean and standard deviation.
- The test is used for testing the hypothesis and is not useful for estimation.
- This test can also be applied to a complex contingency table with several classes and as such is a very useful test in research work.
- This test is an important non-parametric test as no rigid assumptions are necessary in regard to the type of population, no need of parameter values and relatively less mathematical details are involved.