A COURSE MATERIAL ON

BUSINESS RESEARCH

BY

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Research: Definition, Meaning, Importance Types and Qualities of Research

Research is defined as a careful consideration of study regarding a particular concern or a problem using scientific methods. According to the American sociologist Earl Robert Babbie, “Research is a systematic inquiry to describe, explain, predict and control the observed phenomenon. Research involves inductive and deductive methods.”

Meaning:- Research comprises “creative and systematic work undertaken to increase the stock of knowledge, including knowledge of humans, culture and society, and the use of this stock of knowledge to devise new applications.” It is used to establish or confirm facts, reaffirm the results of previous work, solve new or existing problems, support theorems, or develop new theories. A research project may also be an expansion on past work in the field. Research projects can be used to develop further knowledge on a topic, or in the example of a school research project, they can be used to further a student’s research prowess to prepare them for future jobs or reports. To test the validity of instruments, procedures, or experiments, research may replicate elements of prior projects or the project as a whole. The primary purposes of basic research (as opposed to applied research) are documentation, discovery, interpretation, or the research and development (R&D) of methods and systems for the advancement of human knowledge. Approaches to research depend on epistemologies, which vary considerably both within and between humanities and sciences. There are several forms of research: scientific, humanities, artistic, economic, social, business, marketing, practitioner research, life, technological, etc.

Types of Research

1. **Basic Research**

   Basic research is mostly conducted to enhance knowledge. It covers fundamental aspects of research. The main motivation of this research is knowledge expansion. It is a non-commercial research and doesn’t facilitate in creating or inventing anything. For example, an experiment is a good example of basic research.

2. **Applied Research**

   Applied research focuses on analyzing and solving real-life problems. This type of research refers to the study that helps solve practical problems using scientific methods. This research plays an important role in solving issues that impact the overall well-being of humans. For example, finding a specific cure for a disease.

3. **Problem Oriented Research**

   As the name suggests, problem-oriented research is conducted to understand the exact nature of the problem to find out relevant solutions. The term “problem” refers to having issues or two thoughts while making any decisions.

   For e.g Revenue of a car company has decreased by 12% in the last year. The following could be the probable causes: There is no optimum production, poor quality of a product, no advertising, economic conditions etc.

4. **Problem Solving Research**

   This type of research is conducted by companies to understand and resolve their own problems. The problem-solving research uses applied research to find solutions to the existing problems.

5. **Qualitative Research**

   Qualitative research is a process that is about inquiry that helps in-depth understanding of the problems or issues in their natural settings. This is a non- statistical research method.

   Qualitative research is heavily dependent on the experience of the researchers and the questions used to probe the sample. The sample size is usually restricted to 6-10 people in a sample. Open-ended questions are asked in a manner that one question leads to another. The purpose of asking open-ended questions is to gather as much information as possible from the sample.

Following are the methods used for qualitative research:-

- One-to-one interview
- Focus groups
- Ethnographic Research
- Content/ Text Analysis
- Case study research

6. **Quantitative Research**

Qualitative research is a structured way of collecting data and analyzing it to draw conclusions. Unlike qualitative research, this research method uses a computational, statistical and similar method to collect and analyze data. Quantitative data is all about numbers.

Quantitative research involves a larger population as more number of people means more data. In this manner, more data can be analyzed to obtain accurate results. This type of research method uses close-ended questions because, in quantitative research, the researchers are typically looking at measuring the extent and gathering foolproof statistical data.

Online surveys, questionnaires, and polls are preferable data collection tools used in quantitative research. There are various methods of deploying surveys or questionnaires. In recent times online surveys and questionnaires have gained popularity. Survey respondents can receive these surveys on mobile phones, emails or can simply use the internet to access surveys or questionnaires.

Qualities of Research

- **Empirical**: based on observations and experimentation on theories.
- **Systematic:** follows orderly and sequential procedure.
- **Controlled:** all variables except those that are tested/experimented upon are kept constant.
- **Employs hypothesis:** guides the investigation process
- **Analytical:** There is critical analysis of all data used so that there is no error in their interpretation
- **Objective, Unbiased, & Logical:** all findings are logically based on empirical
- **Employs quantitative or statistical methods:** data are transformed into numerical measures and are treated statistically.

Research Application in Functional Area of Business

Part of a business' growth is the deployment of separate departments which functions with specific focus and definitive path. They are structured according to certain business requirements and these departments will vary depending on the type of business being practiced. Knowing the different functional areas of a business is a basic but major necessity for an entrepreneur especially when he's still in the planning stage.

"**Functional Areas**" is defined as the grouping of activities or processes on the basis of their need and wants in accomplishing one or more tasks. It's also an alternative term for business unit. Let's dive right into the list:

1. **Human Resource**

Human resource is the most important asset in the business. The heart of an organization lies on its people. Without people, the day-to-day operation of a business would cease to function. The success of a business relies fully on the hands of the employees working in the company. In order to achieve the company's goals and objectives, the company's Human Resource Department is responsible in recruiting the right people with the required skills, qualifications and experience. They're responsible for determining the salary and wages of different job positions in the company. They're also involved in training employees for their development.

2. Marketing/Promotion

Promotional activities and advertising are the best ways to communicate with your target customers for them to be able to know the company's products and services. Effective marketing and promotional activities will drive long-term success, profitability and growth in market shares. This department is responsible for promoting the business to generate sales and help the company grow. Its function involves creating various marketing strategy and planning promotional campaigns. They are also responsible for monitoring competitor's activities.

One good example of a business that develops an effective marketing strategy is Velvet Caviar and how they have completely dominated the market for iPhone Xs Max Case.

3. Production

It's vital for business that the products are in good quality and free from defects. The production department is concerned with manufacturing the products, where inputs (raw materials) are converted into finished output through a series of production process. Their function is to ensure that the raw materials are made into finished product effectively and efficiently and in good quality. This department should also maintain the optimum inventory level.

4. Sales

In every business, sales department plays the biggest role in any organization's success. The sales department is responsible for generating revenue. The sales department is tasked to ensure that the sale of products and services results to profit. The sales department coordinates with the marketing department in terms of brand-awareness, product-launching and more. From the time the product left the production department. Sales need to develop ways on how to sell the product to their target users/customers.

5. Customer Service Support

The Customer Service department is responsible for interacting with customers regarding inquiries, complaints and orders. It also includes having a help desk/reception and contact centers. It is important for a business to maintain and create relationship with their customers. Customer service should be provided before, during and after the purchase. This department focuses on giving good service support, especially to potential, new and existing customers. Part of a business' customer relationship management is having an efficient customer service support. A good relationship with customers will create customer-loyalty.

6. Accounting and Finance

Cash flow is the lifeblood of any business. It is important to manage the business' cash outflows and inflows. The company can't operate without money. If you can't handle your money properly, you will lose control of your business. That is where the accounting and finance department comes in, which is a part of the organization that manages the company's money. This department is responsible for accounting, auditing, planning, and organizing finances. They're also responsible in producing the company's financial statements.

7. Distribution

No matter how good the product is, it's deemed useless if it won't reach customers. If goods are not suitable for the distribution channel, expenses involved in the distribution will be considered wasted. The distribution department is responsible for receiving orders and delivering orders to the customer at the right place, at the right time.

8. Research and Development

Innovation is the key to every business' future. Through innovation, it will open new competitive advantage for the company. Research and Development acts as the catalyst in the innovation process. They will be responsible for innovations in product, creating its new design and style. As well as for searching new ways of producing their products by being updated with regards to the latest technological and economic trends.

9. Administrative and Management

The administrative and management is the backbone of the business. The administrative and management's function is to handle the business, planning, decision-making, and also financial review. This department links with other departments to ensure the smooth flow of information and operations.

10. Operations

The Operations department is held responsible for overseeing, designing and controlling the process of production and redesigning business operations if necessary. In a manufacturing company, operations department designs processes to produce the product efficiently. They also have to acquire materials and maintenance of equipment, supplies and more.

11. Information Technology Support

Computers and information systems are very essential in business nowadays. The IT department acts as the backbone of a smooth operation involving the latest technology relevant to the business. This department is responsible for creating software/s for other departments, providing direct operating assistance in software-use and data-management to maintain functional areas in the organization.

12. Purchasing

Purchasing is a basic function of an enterprise especially in manufacturing companies. The purchasing department is responsible for the procurement of raw materials, machineries, equipment and supplies. This department ensures that the materials needed are in the right quantity, at the right price, made available in the right time, from the right supplier. It is also their task to inform the top management of the changes of the price or material development that could affect the company's sales.

13. Legal Department

The legal department is tasked to oversee and identify legal issues in all departments. The department may also offer training and assistance with employee manuals to ensure that the company and its employees are kept up-to-date on workplace law and handles filing of legal documents on government agencies. They also handle customer complaints in a professional style and represent the company if sued. They act as the official & formal representative/s in behalf of the company or the founder.

Research and the Scientific Method

For a clear perception of the term research, one should know the meaning of scientific method. The two terms, research and scientific method, are closely related. Research, as we have already stated, can be termed as "an inquiry into the nature of, the reasons for, and the consequences of any particular set of circumstances, whether these circumstances are experimentally controlled or recorded just as they occur.

Further, research implies the researcher is interested in more than particular results; he is interested in the repeatability of the results and in their extension to more complicated and general situations." On the other hand, the philosophy common to all research methods and techniques, although they may vary considerably from one science to another, is usually given the name of scientific method.

Karl Pearson writes, "The scientific method is one and same in the branches (of science) and that method is the method of all logically trained minds … the unity of all sciences consists alone in its methods, not its material; the man who classifies facts of any kind whatever, who sees their mutual relation and describes their sequences, is applying the Scientific Method and is a man of science." Scientific method is the pursuit of truth as determined by logical considerations.

The ideal of science is to achieve a systematic interrelation of facts. Scientific method attempts to achieve "this ideal by experimentation, observation, logical arguments from accepted postulates and a combination of these three in varying proportions." In scientific method, logic aid sin formulating propositions explicitly and accurately so that their possible alternatives become clear .Further, logic develops the consequences of such alternatives, and when these are compared with observable phenomena, it becomes possible for the researcher or the scientist to state which alternatives most in harmony with the observed facts. All this is done through experimentation and survey investigations which constitute the integral parts of scientific method.

Experimentation is done to test hypotheses and to discover new relationships. If any, among variables. But the conclusions drawn on the basis of experimental data are generally criticized for either faulty assumptions, poorly designed experiments, badly executed experiments or faulty interpretations. As such the researcher must pay all possible attention while developing the experimental design and must state only probable inferences. The purpose of survey investigations may also be to provide scientifically gathered information to work as a basis for the researchers for their conclusions.

Basic Postulates of Scientific Method

The scientific method is, thus, based on certain basic postulates which can be stated as under:

(i) It relies on empirical evidence;

(ii) It utilizes relevant concepts;

(iii) It is committed to only objective considerations;

(iv) It presupposes ethical neutrality, i.e., it aims at nothing but making only adequate and correct statements about population objects;

(v) It results into probabilistic predictions;

(vi) Its methodology is made known to all concerned for critical scrutiny are for use in testing the conclusions through replication;

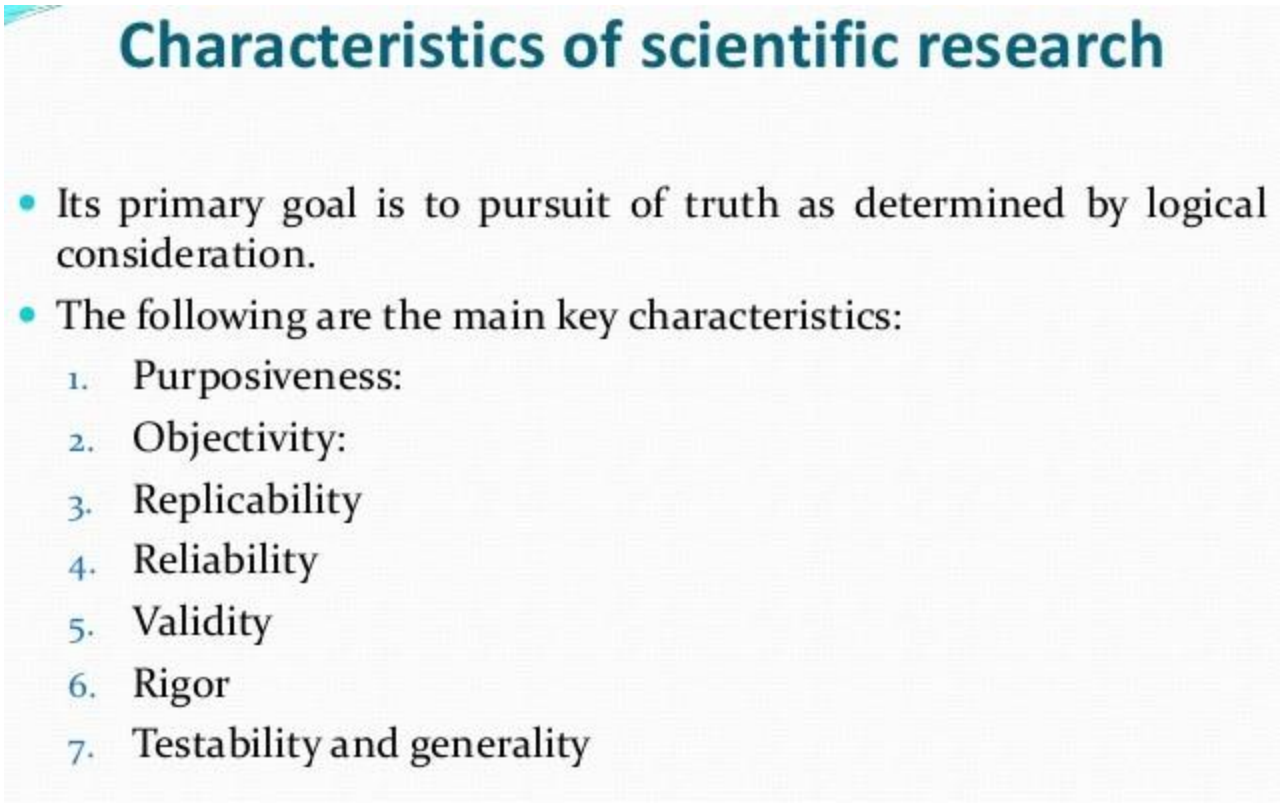
(vii) It aims at formulating most general axioms or what can be termed as scientific theories.

Thus, "the scientific method encourages a rigorous, impersonal mode of procedure dictated by the demands of logic and objective procedure." Accordingly, scientific method implies an objective, logical and systematic method, i.e., a method free from personal bias or prejudice, a method to ascertain demonstrable qualities of a phenomenon capable of being verified, a method wherein the researcher is guided by the rules of logical reasoning, a method wherein the investigation proceeds inane orderly manner and a method that implies internal consistency.

Characteristics of Scientific Method

Five (5) Major Characteristics of the Scientific Method

The scientific method is the system used by scientists to explore data, generate and test hypotheses, develop new theories and confirm or reject earlier results. Although the exact methods used in the different sciences vary (for example, physicists and psychologists work in very different ways), they share some fundamental attributes that may be called characteristics of the scientific method.



1. Empirical Observation

The scientific method is empirical. That is, it relies on direct observation of the world, and disdains hypotheses that run counter to observable fact. This contrasts with methods that rely on pure reason (including that proposed by Plato) and with methods that rely on emotional or other subjective factors.

2. Replicable Experiments

Scientific experiments are replicable. That is, if another person duplicates the experiment, he or she will get the same results. Scientists are supposed to publish enough of their method so that another person, with appropriate training, could replicate the results. This contrasts with methods that rely on experiences that are unique to a particular individual or a small group of individuals.

3. Provisional Results

Results obtained through the scientific method are provisional; they are (or ought to be) open to question and debate. If new data arise that contradict a theory, that theory must be modified. For example, the phlogiston theory of fire and combustion was rejected when evidence against it arose.

4. Objective Approach

The scientific method is objective. It relies on facts and on the world as it is, rather than on beliefs, wishes or desires. Scientists attempt (with varying degrees of success) to remove their biases when making observations.

5. Systematic Observation

Strictly speaking, the scientific method is systematic; that is, it relies on carefully planned studies rather than on random or haphazard observation. Nevertheless, science can begin from some random observation. Isaac Asimov said that the most exciting phrase to hear in science is not “Eureka!” but “That’s funny.” After the scientist notices something funny, he or she proceeds to investigate it systematically.

Steps in Research Process

Scientific Research involves a systematic process that focuses on being objective and gathering a multitude of information for analysis so that the researcher can come to a conclusion. This process is used in all research and evaluation projects, regardless of the research method (scientific method of inquiry, evaluation research, or action research). The process focuses on testing hunches or ideas in a park and recreation setting through a systematic process. In this process, the study is documented in such a way that another individual can conduct the same study again. Any research done without documenting the study so that others can review the process and results is not an investigation using the scientific research process. The scientific research process is a multiple-step process where the steps are interlinked with the other steps in the process. If changes are made in one step of the process, the researcher must review all the other steps to ensure that the changes are reflected throughout the process. Parks and recreation professionals are often involved in conducting research or evaluation projects within the agency. These professionals need to understand the eight steps of the research process as they apply to conducting a study.

Step 1: Identify the Problem

The first step in the process is to identify a problem or develop a research question. The research problem may be something the agency identifies as a problem, some knowledge or information that is needed by the agency, or the desire to identify a recreation trend nationally.

Step 2: Review the Literature

Now that the problem has been identified, the researcher must learn more about the topic under investigation. To do this, the researcher must review the literature related to the research problem. This step provides foundational knowledge about the problem area. The review of literature also educates the researcher about what studies have been conducted in the past, how these studies were conducted, and the conclusions in the problem area. In the obesity study, the review of literature enables the programmer to discover horrifying statistics related to the long-term effects of childhood obesity in terms of health issues, death rates, and projected medical costs. In addition, the programmer finds several articles and information from the Centers for Disease Control and Prevention that describe the benefits of walking 10,000 steps a day. The information discovered during this step helps the programmer fully understand the magnitude of the problem, recognize the future consequences of obesity, and identify a strategy to combat obesity (i.e., walking).

Step 3: Clarify the Problem

Many times the initial problem identified in the first step of the process is too large or broad in scope. In step 3 of the process, the researcher clarifies the problem and narrows the scope of the study. This can only be done

after the literature has been reviewed. The knowledge gained through the review of literature guides the researcher in clarifying and narrowing the research project. In the example, the programmer has identified childhood obesity as the problem and the purpose of the study. This topic is very broad and could be studied based on genetics, family environment, diet, exercise, self-confidence, leisure activities, or health issues. All of these areas cannot be investigated in a single study; therefore, the problem and purpose of the study must be more clearly defined. The programmer has decided that the purpose of the study is to determine if walking 10,000 steps a day for three days a week will improve the individual's health. This purpose is more narrowly focused and researchable than the original problem.

Step 4: Clearly Define Terms and Concepts

Terms and concepts are words or phrases used in the purpose statement of the study or the description of the study. These items need to be specifically defined as they apply to the study. Terms or concepts often have different definitions depending on who is reading the study. To minimize confusion about what the terms and phrases mean, the researcher must specifically define them for the study. In the obesity study, the concept of "individual's health" can be defined in hundreds of ways, such as physical, mental, emotional, or spiritual health. For this study, the individual's health is defined as physical health. The concept of physical health may also be defined and measured in many ways. In this case, the programmer decides to more narrowly define "individual health" to refer to the areas of weight, percentage of body fat, and cholesterol. By defining the terms or concepts more narrowly, the scope of the study is more manageable for the programmer, making it easier to collect the necessary data for the study

Step 5: Define the Population

Research projects can focus on a specific group of people, facilities, park development, employee evaluations, programs, financial status, marketing efforts, or the integration of technology into the operations. For example, if a researcher wants to examine a specific group of people in the community, the study could examine a specific age group, males or females, people living in a specific geographic area, or a specific ethnic group. Literally thousands of options are available to the researcher to specifically identify the group to study. The research problem and the purpose of the study assist the researcher in identifying the group to involve in the study. In research terms, the group to involve in the study is always called the population. Defining the population assists the researcher in several ways. First, it narrows the scope of the study from a very large population to one that is manageable. Second, the population identifies the group that the researcher's efforts will be focused on within the study. This helps ensure that the researcher stays on the right path during the study. Finally, by defining the population, the researcher identifies the group that the results will apply to at the conclusion of the study.

Step 6: Develop the Instrumentation Plan

The plan for the study is referred to as the instrumentation plan. The instrumentation plan serves as the road map for the entire study, specifying who will participate in the study; how, when, and where data will be collected; and the content of the program. In the obesity study, the researcher has decided to have the children participate in a walking program for six months. The group of participants is called the sample, which is a smaller group selected from the population specified for the study. The study cannot possibly include every 10- to 12-year-old child in the community, so a smaller group is used to represent the population. The researcher develops the plan for the walking program, indicating what data will be collected, when and how the data will be collected, who will collect the data, and how the data will be analyzed. The instrumentation plan specifies all the steps that must be completed for the study. This ensures that the programmer has carefully thought through all these decisions and that she provides a step-by-step plan to be followed in the study.

Step 7: Collect Data

Once the instrumentation plan is completed, the actual study begins with the collection of data. The collection of data is a critical step in providing the information needed to answer the research question. Every study includes the collection of some type of data—whether it is from the literature or from subjects—to answer the research question. Data can be collected in the form of words on a survey, with a questionnaire, through observations, or from the literature. In the obesity study, the programmers will be collecting data on the defined variables: weight, percentage of body fat, cholesterol levels, and the number of days the person walked a total of 10,000 steps during the class.

The researcher collects these data at the first session and at the last session of the program. These two sets of data are necessary to determine the effect of the walking program on weight, body fat, and cholesterol level. Once the data are collected on the variables, the researcher is ready to move to the final step of the process, which is the data analysis.

Step 8: Analyze the Data

All the time, effort, and resources dedicated to steps 1 through 7 of the research process culminate in this final step. The researcher finally has data to analyze so that the research question can be answered. In the instrumentation plan, the researcher specified how the data will be analyzed. The researcher now analyzes the data according to the plan. The results of this analysis are then reviewed and summarized in a manner directly related to the research questions. In the obesity study, the researcher compares the measurements of weight, percentage of body fat, and cholesterol that were taken at the first meeting of the subjects to the measurements of the same variables at the final program session. These two sets of data will be analyzed to determine if there was a difference between the first measurement and the second measurement for each individual in the program. Then, the data will be analyzed to determine if the differences are statistically significant. If the differences are statistically significant, the study validates the theory that was the focus of the study. The results of the study also provide valuable information about one strategy to combat childhood obesity in the community.

As you have probably concluded, conducting studies using the eight steps of the scientific research process requires you to dedicate time and effort to the planning process. You cannot conduct a study using the scientific research process when time is limited or the study is done at the last minute. Researchers who do this conduct studies that result in either false conclusions or conclusions that are not of any value to the organization.

Research Design, Feature of a Good Research Design

Research Design is defined as a framework of methods and techniques chosen by a researcher to combine various components of research in a reasonably logical manner so that the research problem is efficiently handled. It provides insights about “how” to conduct research using a particular methodology.

Types of Research Design

A researcher must have a clear understanding of the various types of research design to select which type of research design to implement for a study. Research design can be broadly classified into quantitative and qualitative research design.

1. **Qualitative Research Design**

Qualitative research is implemented in cases where a relationship between collected data and observation is established on the basis of mathematical calculations. Theories related to a naturally existing phenomenon can be proved or disproved using mathematical calculations. Researchers rely on qualitative research design where they are expected to conclude “why” a particular theory exists along with “what” respondents have to say about it.

2. **Quantitative Research Design**

Quantitative research is implemented in cases where it is important for a researcher to have statistical conclusions to collect actionable insights. Numbers provide a better perspective to make important business decisions. Quantitative research design is important for the growth of any organization because any conclusion drawn on the basis of numbers and analysis will only prove to be effective for the business.

Further, research design can be divided into five types :

(I) Descriptive Research Design: In a descriptive research design, a researcher is solely interested in describing the situation or case under his/her research study. It is a theory-based research design which is created by gather, analyze and presents collected data. By implementing an in-depth research design such as this, a researcher can provide insights into the why and how of research.

(II) Experimental Research Design: Experimental research design is used to establish a relationship between the cause and effect of a situation. It is a causal research design where the effect caused by the independent variable on the dependent variable is observed. For example, the effect of an independent variable such as price on a dependent variable such as customer satisfaction or brand loyalty is monitored. It is a highly practical

research design method as it contributes towards solving a problem at hand. The independent variables are manipulated to monitor the change it has on the dependent variable. It is often used in social sciences to observe human behavior by analyzing two groups – effect of one group on the other.

(III) Correlational Research Design: Correlational research is a non-experimental research design technique which helps researchers to establish a relationship between two closely connected variables. Two different groups are required to conduct this research design method. There is no assumption while evaluating a relationship between two different variables and statistical analysis techniques are used to calculate the relationship between them.

Correlation between two variables is concluded using a correlation coefficient, whose value ranges between -1 and +1. If the correlation coefficient is towards +1, it indicates a positive relationship between the variables and -1 indicates a negative relationship between the two variables.

(IV) Diagnostic Research Design: In the diagnostic research design, a researcher is inclined towards evaluating the root cause of a specific topic. Elements that contribute towards a troublesome situation are evaluated in this research design method.

There are three parts of diagnostic research design:

- Inception of the issue
- Diagnosis of the issue
- Solution for the issue

(V) Explanatory Research Design: In exploratory research design, the researcher's ideas and thoughts are key as it is primarily dependent on their personal inclination about a particular topic. Explanation about unexplored aspects of a subject is provided along with details about what, how and why related to the research questions.

Features of a Good Research Design

The features of good research design is often characterized by adjectives like flexible, appropriate, efficient, economical and so on. Generally, the design which minimizes bias and maximizes the reliability of the data collected and analyzed is considered a good design. The design which gives the smallest experimental error is supposed to be the best design in many investigations. Similarly, a design which yields maximal information and provides an opportunity for considering many different aspects of a problem is considered most appropriate and efficient design in respect of many research problems. Thus, the question of good design is related to the purpose or objective of the research problem and also with the nature of the problem to be studied. A design may be quite suitable in one case, but may be found wanting in one respect or the other in the context of some other research problem. One single design cannot serve the purpose of all types of research problems.

A research design appropriate for a particular research problem, usually involves the consideration of the following factors:

1. The means of obtaining information;
2. The availability and skills of the researcher and his staff, if any;
3. The objective of the problem to be studied;
4. The nature of the problem to be studied; and
5. The availability of time and money for the research work.

Use of a Good Research Design: Qualitative and Quantitative Approach

When to use qualitative vs. quantitative research

Quantitative data can help you see the big picture. Qualitative data adds the details and can also give a human voice to your survey results.

Let's see how to use each method in a research project.

- **Formulating hypotheses:** Qualitative research helps you gather detailed information on a topic. You can use it to initiate your research by discovering the problems or opportunities people are thinking about. Those ideas can become hypotheses to be proven through quantitative research.
- **Validating your hypotheses:** Quantitative research will get you numbers that you can apply statistical analysis to in order to validate your hypotheses. Was that problem real or just someone's perception? The hard facts obtained will enable you to make decisions based on objective observations.
- **Finding general answers:** Quantitative research usually has more respondents than qualitative research because it is easier to conduct a multiple-choice survey than a series of interviews or focus groups. Therefore it can help you definitely answer broad questions like: Do people prefer you to your competitors? Which of your company's services are most important? What ad is most appealing?
- **Incorporating the human element:** Qualitative research can also help in the final stages of your project. The quotes you obtained from open-ended questions can put a human voice to the objective numbers and trends in your results. Many times it helps to hear your customers describe your company in their own words to uncover your blind spots. Qualitative data will get you that.

How to balance qualitative and quantitative research?

These two research methods don't conflict with each other. They actually work much better as a team. In a world of Big Data, there's a wealth of statistics and figures that form the strong foundation on which your decisions can rest. But that foundation is incomplete without the information collected from real people that gives the numbers meaning.

So how do you put these two forms of research together? Qualitative research is almost always the starting point when you seek to discover new problems and opportunities–which will help you do deeper research later. Quantitative data will give you measurements to confirm each problem or opportunity and understand it.

How about an example? Let's say you held a conference and wanted feedback from your attendees. You can probably already measure several things with quantitative research, such as attendance rate, overall satisfaction, quality of speakers, value of information given, etc. All these questions can be given in a closed-ended and measurable way.

But you also may want to provide a few open-ended, qualitative research questions to find out what you may have overlooked. You could use questions like:

- What did you enjoy most about the conference?
- How could we improve your experience?
- Is there any feedback on the conference you think we should be aware of?

If you discover any common themes through these qualitative questions, you can decide to research them more in depth, make changes to your next event, and make sure to add quantitative questions about these topics after the next conference.

For example, let's say several attendees said that their least favorite thing about the conference was the difficult-to-reach location. Next time, your survey might ask quantitative questions like how satisfied people were with the location, or let respondents choose from a list of potential sites they would prefer.

Open-ended vs. close-ended questions. A good way of recognizing when you want to switch from one method to the other is to look at your open-ended questions and ask yourself why you are using them.

For example, if you asked: "What do you think of our ice cream prices?", people would give you feedback in their own words and you will probably get some out-of-the-box answers.

If that's not what you're looking for, you should consider using an easily quantifiable response. For example:

Relative to our competitors, do you think our ice cream prices are:

- Higher
- About the same
- Lower

This kind of question will give your survey respondents clarity and in turn it will provide you with consistent data that is easy to analyze.

How to get qualitative data?

There are many methods you can use to conduct qualitative research that will get you richly detailed information on your topic of interest.

- One-on-one conversations that go deep into the topic at hand.
- **Case studies.** Collections of client stories from in-depth interviews.
- **Expert opinions.** High-quality information from well-informed sources.
- **Focus groups.**In-person or online conversation with small groups of people to listen to their views on a product or topic.
- **Open-ended survey questions.**A text box in a survey that lets the respondent express their thoughts on the matter at hand freely.
- **Observational research.**Observing people during the course of their habitual routines to understand how they interact with a product, for example.

However, this open-ended method of research does not always lend itself to bringing you the most accurate results to big questions. And analyzing the results is hard because people will use different words and phrases to describe their points of view, and may not even talk about the same things if they find space to roam with their responses.

In some cases, it may be more effective to go 'full quantitative' with your questions.

Why Collect Quantitative Data?

Qualitative survey questions can run the risk of being too vague. To avoid confusing your respondents, you may want to eschew questions like, "What do you think about our internet service?" Instead you could ask a closed-ended, quantitative question like in the following example.

The internet service is reliable:

- Always
- Most of the time
- About half the time
- Once in a while
- Never

Qualitative questions take longer to answer. Survey respondents don't always have the patience to reflect on what they are being asked and write long responses that accurately express their views. It's much faster to choose one of several pre-loaded options in a questionnaire. Using quantitative questions helps you get more questions in your survey and more responses out of it.

Quantitative survey questions are just more… quantifiable. Even word responses in closed-ended questionnaires can be assigned numerical values that you can later convert into indicators and graphs. This means that the overall quality of the data is better. Remember that the most accurate data leads you to the best possible decisions.

Comparison Pros and Cons of Qualitative and Quantitative Research

In the scientific community, there is great debate between qualitative and quantitative research methods. Despite the criticism that qualitative methods are interpretive and invalid as scientific evidence, the real discrepancy lies within the types of data that each method produces. Quantitative data measures quantifiable terms, such as "how much," "how long" and "how many," while qualitative data measures the reasons behind behavior, such as the "how" and "why." While neither method is "better" than the other, there are advantages and disadvantages to both.

Qualitative: Pros

Qualitative research allows one to explore topics in more depth and detail than quantitative research. Also, qualitative research is often less expensive than quantitative research, because you don't need to recruit as many participants or use extensive methods. Another pro of qualitative research is that it offers flexibility as far as locations and timing because you don't need to interview a large number of people at once.

Qualitative: Cons

One major disadvantage of qualitative research is that it cannot quantify how many of your audience answer one way or another. This makes it extremely difficult to create any type of solid statistic. Another con is that you cannot generalize your findings. As opposed to quantitative surveys, qualitative research does not allow you to use your findings as a basis for a broader audience or the public in general.

Quantitative: Pros

One of the pros to quantitative research involves the fast speed that data can be collected. This data can also be analyzed fairly quickly. In addition, using statistically valid random samples, a survey can quickly be generalized to the entire population. Another advantage involves the planning process for programs and messages. With the reliable, repeatable information that quantitative surveys can provide, a trusted set of statistics can give confidence when making future plans. Quantitative research can also be anonymous, which is useful when dealing with sensitive topics. Another major pro of quantitative research is that it allows you to generalize your findings beyond the participant group.

Quantitative: Cons

One con of quantitative research is the limited ability to probe answers. Also, people who are willing to respond may share characteristics that don't apply to the audience as a whole, creating a potential bias in the study. In addition, quantitative research experiments can be costly.

Qualitative Techniques: Projective Techniques, Depth Interviews, Experience survey, Focus groups, Observation

1. ### Projective Techniques

Projective Techniques are indirect and unstructured methods of investigation which have been developed by the psychologists and use projection of respondents for inferring about underline motives, urges or intentions which cannot be secure through direct questioning as the respondent either resists to reveal them or is unable to figure out himself. These techniques are useful in giving respondents opportunities to express their attitudes without personal embarrassment. These techniques helps the respondents to project his own attitude and feelings unconsciously on the subject under study. Thus Projective Techniques play a important role in motivational researches or in attitude surveys.

Important Projective Techniques

(I) Word Association Test.

(II) Completion Test.

(III) Construction Techniques

(IV) Expression Techniques

(I) Word Association Test: An individual is given a clue or hint and asked to respond to the first thing that comes to mind. The association can take the shape of a picture or a word. There can be many interpretations of the same thing. A list of words is given and you don't know in which word they are most interested. The interviewer records the responses which reveal the inner feeling of the respondents. The frequency with which any word is given a response and the amount of time that elapses before the response is given are important for the researcher. For eg: Out of 50 respondents 20 people associate the word " Fair" with "Complexion".

(II) Completion Test: In this the respondents are asked to complete an incomplete sentence or story. The completion will reflect their attitude and state of mind.

(III) Construction Test: This is more or less like completion test. They can give you a picture and you are asked to write a story about it. The initial structure is limited and not detailed like the completion test. For eg: 2 cartoons are given and a dialogue is to written.

(IV) Expression Techniques: In this the people are asked to express the feeling or attitude of other people.

Disadvantages of Projective Techniques

- Highly trained interviewers and skilled interpreters are needed.
- Interpreter's bias can be there.
- It is a costly method.
- The respondent selected may not be representative of the entire population.

2. Depth Interviews

A qualitative data collection method, in-depth interviews offer the opportunity to capture rich, descriptive data about people's behaviors, attitudes and perceptions, and unfolding complex processes. They can be used as a standalone research method or as part of a multi method design, depending on the needs of the research.

How is an in depth interview carried out?

In depth interviews are normally carried out face to face so that a rapport can be created with respondents. Body language is also used to add a high level of understanding to the answers. Telephones can also be used by a skilled researcher with little loss of data and at a tenth of the cost.

The style of the interview depends on the interviewer. Successful in-depth interviewers listen rather than talk. They have a clear line of questioning and use body language to build rapport.

3. Experience Survey

Most often taking the form of a text box in a survey, open-ended questions allow your respondents to provide a unique answer (as opposed to providing a list of predetermined responses to select from). This approach gives respondents the freedom to say exactly what they feel about a topic, which provides you with exploratory data that may reveal unforeseen opportunities, issues, or quotes. You can then use this information to support the hard numbers you've collected in the survey. Often it is these quotes or examples that create more powerful statements than many averages and percentages.

4. Focus Groups

Usually done in person or online, a focus group asks a small group of people to discuss their thoughts on a given subject. A focus group allows you to gauge the reactions of a small number of your target audience in a controlled but free-flowing group discussion. This form of research is a great way to test how your target audience would perceive a new product or marketing strategy.

5. **Observational Research**

This approach involves observing customers or people in their actual element. A perfect example would be watching shoppers while they visit your store. How long does it take them to find what they are looking for? Do they look comfortable interacting with your staff? Where do they go first, second? When do they leave without making a purchase? These real-world observations can lead you to findings that more direct forms of research, like focus groups and interviews, would miss.

Descriptive Research Design: Concept, Types and Uses

Descriptive Research is research used to "**describe**" a situation, subject, behavior, or phenomenon. It is used to answer questions of who, what, when, where, and how associated with a particular research question or problem. Descriptive studies are often described as studies that are concerned with finding out "**what is**". It attempts to gather quantifiable information that can be used to statistically analyze a target audience or a particular subject.

Description research is used to observe and describe a research subject or problem without influencing or manipulating the variables in any way. Hence, these studies are really correlational or observational, and not truly experimental. This type of research is conclusive in nature, rather than exploratory. Therefore, descriptive research does not attempt to answer "**why**" and is not used to discover inferences, make predictions or establish causal relationships.

Descriptive research is used extensively in social science, psychology and educational research. It can provide a rich data set that often brings to light new knowledge or awareness that may have otherwise gone unnoticed or encountered. It is particularly useful when it is important to gather information with disruption of the subjects or when it is not possible to test and measure large numbers of samples. It allows researchers to observe natural behaviors without affecting them in any way. Following is a list of research questions or problems that may lend themselves to descriptive research:-

- Market researchers may want to observe the habits of consumers.
- A company may be wanting to evaluate the morale of the staff.
- A school district may research whether or not students are more likely to access online textbooks than to use printed copies.
- A school district may wish to assess teachers' attitudes about using technology in the classroom.
- An educational software company may want to know what aspects of the software make it more likely to be used by students.
- A researcher may wish to study the impact of hands-on activities and laboratory experiments on students' perceptions of science.
- A researcher could be studying whether or not the availability of hiking/biking trails increases the physical activity levels in a neighborhood.

Types of Descriptive Research

In some types of descriptive research, the researcher does not interact with the subjects. In other types, the researcher does interact with the subjects and collects information directly from them. Some descriptive studies may be cross-sectional, whereby the researcher has a one-time interaction with the test subjects. Other studies may be longitudinal, where the same test subjects are followed over time. There are three main methods that may be used in descriptive research:-

- **Observational Method:** Used to review and record the actions and behaviors of a group of test subjects in their natural environment. The research typically does not have interaction with the test subject.
- **Case Study Method:** This is a much more in-depth student of an individual or small group of individuals. It may or may not involve interaction with the test subjects.
- **Survey Method:** Researchers interact with individual test subjects by collecting information through the use of surveys or interviews.

The data collected from descriptive research may be quantitative, qualitative or both. The quantitative data is typically presented in the form of descriptive statistics that provide basic information such as the mean, median, and mode of a data set. Quantitative date may also be tabulated along a continuum in numerical form, such as scores on a test. It can also be used to describe categories of information or patterns of interactions. Such quantitative data is typically represented in tables, graphs, and charts which makes it user-friendly and easy to interpret. Qualitative data, such as the type of narrative data collected in a case study, may be organized into patterns that emerge or it may be classified in some way, but requires more detailed analysis.

Sampling: Basic Concept: Defining the Universe

Sampling is a process used in statistical analysis in which a predetermined number of observations are taken from a larger population. The methodology used to sample from a larger population depends on the type of analysis being performed but may include simple random sampling or systematic sampling.

In business, a CPA performing an audit uses sampling to determine the accuracy of account balances in the financial statements, and managers use sampling to assess the success of the firm's marketing efforts.

The sample should be a representation of the entire population. When taking a sample from a larger population, it is important to consider how the sample is chosen. To get a representative sample, the sample must be drawn randomly and encompass the whole population. For example, a lottery system could be used to determine the average age of students in a university by sampling 10% of the student body.

A good sample is one which satisfies all or few of the following conditions-

(i) Representativeness: When sampling method is adopted by the researcher, the basic assumption is that the samples so selected out of the population are the best representative of the population under study. Thus good samples are those who accurately represent the population. Probability sampling technique yield representative samples. On measurement terms, the sample must be valid. The validity of a sample depends upon its accuracy.

(ii) Accuracy: Accuracy is defined as the degree to which bias is absent from the sample. An accurate (unbiased) sample is one which exactly represents the population. It is free from any influence that causes any differences between sample value and population value.

(iii) Size: A good sample must be adequate in size and reliable. The sample size should be such that the inferences drawn from the sample are accurate to a given level of confidence to represent the entire population under study.

The size of sample depends on number of factors. Some important among them are:-

(i) Homogeneity or Heterogeneity of the universe: Selection of sample depends on the nature of the universe. It says that if the nature of universe is homogeneous then a small sample will represent the behavior of entire universe. This will lead to selection of small sample size rather than a large one. On the other hand, if the universe is heterogeneous in nature then samples are to be chosen as from each heterogeneous unit.

(ii) Number of classes proposed: If a large number of class intervals to be made then the size of sample should be more because it has to represent the entire universe. In case of small samples there is the possibility that some samples may not be included.

(iii) Nature of study: The size of sample also depends on the nature of study. For an intensive study which may be for a long time, large samples are to be chosen. Similarly, in case of general studies large number of

respondents may be appropriate one but if the study is of technical in nature then the selection of large number of respondents may cause difficulty while gathering information.

Sampling is the act, process, or technique of selecting a representative part of a population for the purpose of determining the characteristics of the whole population. In other words, the process of selecting a sample from a population using special sampling techniques called sampling. It should be ensured in the sampling process itself that the sample selected is representative of the population.

Examples of Sample Tests for Marketing

Businesses aim to sell their products and/or services to target markets. Before presenting products to the market, companies generally identify the needs and wants of their target audience. To do so, they may employ using a sample of the population to gain a better understanding of those needs to later create a product and/or service that meets those needs. Gathering the opinions of the sample helps to identify the needs of the whole.

UNIVERSE OR POPULATION

The population or universe represents the entire group of units which is the focus of the study. Thus, the population could consist of all the persons in the country, or those in a particular geographical location, or a special ethnic or economic group, depending on the purpose and coverage of the study. A population could also consist on non-human units such as farms, houses or business establishments.

Sample, Characteristics of a Good Sample

Sample

A sample is a smaller, manageable version of a larger group. It is a subset containing the characteristics of a larger population. Samples are used in statistical testing when population sizes are too large for the test to include all possible members or observations. A sample should represent the whole population and not reflect bias toward a specific attribute.

In basic terms, a population is the total number of individuals, animals, items, observation, data, etc. of any given subject. For example, as of 2017, the population of the world was 7.5 billion of which 49.6% were female and 50.4% were male. The total number of people in any given country can also be a population size. The total number of students in a city can be taken as a population, and the total number of dogs in a city is also a population size. Scientists, researchers, marketers, academicians, and any related or interested party trying to draw data from a group will find that a population size may be too large to monitor. Consider a team of academic researchers that want to, say, know the number of students that studied for less than 40 hours for the CFA exam in 2016 and still passed. Since more than 200,000 people globally take the exam each year, reaching out to each and every exam participant might be extremely tedious and time consuming. In fact, by the time the data from the population has been collected and analyzed, a couple of years would have passed, making the analysis worthless since a new population would have emerged.

Characteristics of a Good Sample

(1) Goal-oriented: A sample design should be goal oriented. It is means and should be oriented to the research objectives and fitted to the survey conditions.

(2) Accurate representative of the universe: A sample should be an accurate representative of the universe from which it is taken. There are different methods for selecting a sample. It will be truly representative only when it represents all types of units or groups in the total population in fair proportions. In brief sample should be selected carefully as improper sampling is a source of error in the survey.

(3) Proportional: A sample should be proportional. It should be large enough to represent the universe properly. The sample size should be sufficiently large to provide statistical stability or reliability. The sample size should give accuracy required for the purpose of particular study.

(4) Random selection: A sample should be selected at random. This means that any item in the group has a full and equal chance of being selected and included in the sample. This makes the selected sample truly representative in character.

(5) Economical: A sample should be economical. The objectives of the survey should be achieved with minimum cost and effort.

(6) Practical: A sample design should be practical. The sample design should be simple i.e. it should be capable of being understood and followed in the fieldwork.

(7) Actual information provider: A sample should be designed so as to provide actual information required for the study and also provide an adequate basis for the measurement of its own reliability.

In brief, a good sample should be truly representative in character. It should be selected at random and should be adequately proportional. These, in fact, are the attributes of a good sample.

Data Analysis: Editing, Coding, Tabular Representation of Data

Data Analysis is a process of inspecting, cleaning, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, while being used in different business, science, and social science domains. In today's business, data analysis is playing a role in making decisions more scientific and helping the business achieve effective operation.

EDITING

EDITING is the process of checking and adjusting responses in the completed questionnaires for omissions, legibility, and consistency and readying them for coding and storage.

Purpose of Editing

Purpose of Editing For consistency between and among responses. For completeness in responses– to reduce effects of item non-response. To better utilize questions answered out of order. To facilitate the coding process.

Basic Principles of Editing

1. Checking of the no. of Schedules / Questionnaire)
2. Completeness (Completed in filling of questions)
3. Legibility.
4. To avoid Inconstancies in answers.
5. To Maintain Degree of Uniformity.
6. To Eliminate Irrelevant Responses.

Types of Editing

1. Field Editing

   Preliminary editing by a field supervisor on the same day as the interview to catch technical omissions, check legibility of handwriting, and clarify responses that are logically or conceptually inconsistent.

2. Office Editing

   Editing performed by a central office staff; often done more rigorously than field editing.

CODING

The process of identifying and classifying each answer with a numerical score or other character symbol. The numerical score or symbol is called a code, and serves as a rule for interpreting, classifying, and recording data. Identifying responses with codes is necessary if data is to be processed by computer.

Coded data is often stored electronically in the form of a data matrix – a rectangular arrangement of the data into rows (representing cases) and columns (representing variables) The data matrix is organized into fields, records, and files:

Field: A collection of characters that represents a single type of data.

Record: A collection of related fields, i.e., fields related to the same case (or respondent).

File: A collection of related records, i.e. records related to the same sample.

Tabular Representation of Data

Presentation of data is of utter importance nowadays. After all everything that's pleasing to our eyes never fails to grab our attention. Presentation of data refers to an exhibition or putting up data in an attractive and useful manner such that it can be easily interpreted.

Tabular Representation

A table facilitates representation of even large amounts of data in an attractive, easy to read and organized manner. The data is organized in rows and columns. This is one of the most widely used forms of presentation of data since data tables are easy to construct and read.

Components of Data Tables

- Table Number: Each table should have a specific table number for ease of access and locating. This number can be readily mentioned anywhere which serves as a reference and leads us directly to the data mentioned in that particular table.
- Title: A table must contain a title that clearly tells the readers about the data it contains, time period of study, place of study and the nature of classification of data.
- Headnotes: A headnote further aids in the purpose of a title and displays more information about the table. Generally, headnotes present the units of data in brackets at the end of a table title.
- Stubs: These are titles of the rows in a table. Thus a stub display information about the data contained in a particular row.
- Caption: A caption is the title of a column in the data table. In fact, it is a counterpart if a stub and indicates the information contained in a column.
- Body or field: The body of a table is the content of a table in its entirety. Each item in a body is known as a 'cell'.
- Footnotes: Footnotes are rarely used. In effect, they supplement the title of a table if required.
- Source: When using data obtained from a secondary source, this source has to be mentioned below the footnote.

Construction of Data Tables

There are many ways for construction of a good table. However, some basic ideas are:

- The title should be in accordance with the objective of study: The title of a table should provide a quick insight into the table.
- Comparison: If there might arise a need to compare any two rows or columns then these might be kept close to each other.
- Alternative location of stubs: If the rows in a data table are lengthy, then the stubs can be placed on the right-hand side of the table.
- Headings: Headings should be written in a singular form. For example, 'good' must be used instead of 'goods'.
- Footnote: A footnote should be given only if needed.
- Size of columns: Size of columns must be uniform and symmetrical.
- Use of abbreviations: Headings and sub-headings should be free of abbreviations.
- Units: There should be a clear specification of units above the columns.

The Advantages of Tabular Representation

- Ease of representation: A large amount of data can be easily confined in a data table. Evidently, it is the simplest form of data presentation.

- Ease of analysis: Data tables are frequently used for statistical analysis like calculation of central tendency, dispersion etc.
- Helps in comparison: In a data table, the rows and columns which are required to be compared can be placed next to each other. To point out, this facilitates comparison as it becomes easy to compare each value.
- Economical: Construction of a data table is fairly easy and presents the data in a manner which is really easy on the eyes of a reader. Moreover, it saves time as well as space.

Hypothesis: Framing Null Hypothesis and Alternative Hypothesis

Hypothesis

A hypothesis (plural: hypotheses), in a scientific context, is a testable statement about the relationship between two or more variables or a proposed explanation for some observed phenomenon. In a scientific experiment or study, the hypothesis is a brief summation of the researcher's prediction of the study's findings, which may be supported or not by the outcome. Hypothesis testing is the core of the scientific method.

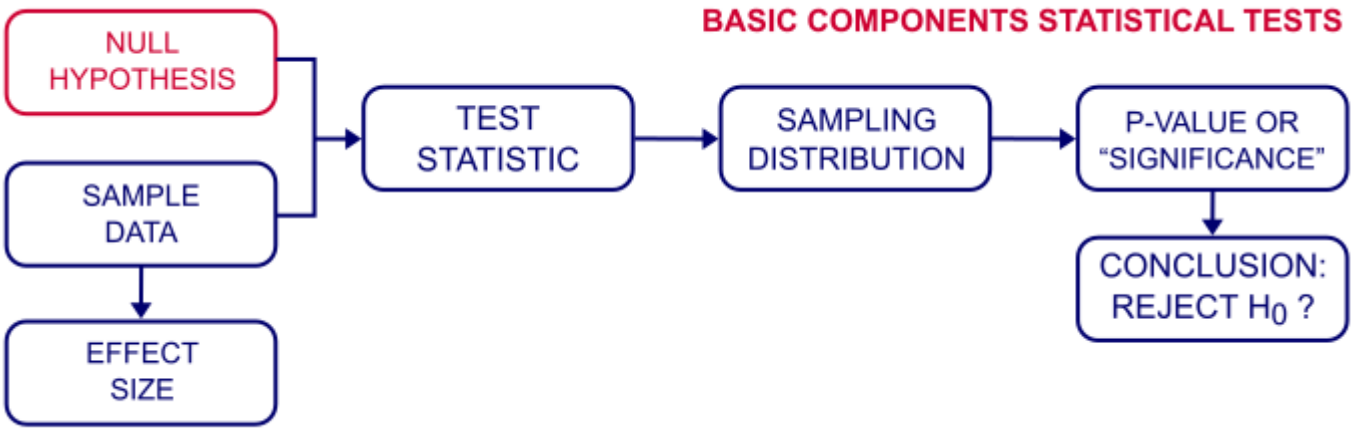
The researcher's prediction is usually referred to as the alternative hypothesis, and any other outcome as the null hypothesis — basically, the opposite outcome to what is predicted. (However, the terms are reversed if the researchers are predicting no difference or change, hypothesizing, for example, that the incidence of one variable will not increase or decrease in tandem with the other.) The null hypothesis satisfies the requirement for falsifiability: the capacity for a proposition to be proven false, which some schools of thought consider essential to the scientific method. According to others, however, testability is adequate, on the grounds that if there is sufficient support for a hypothesis it is not necessary to be able to conceive of a contrary outcome.

Framing Null Hypothesis

The null hypothesis is a general statement or default position that there is no relationship between two measured phenomena, or no association among groups. Testing (accepting, approving, rejecting, or disproving) the null hypothesis—and thus concluding that there are or are not grounds for believing that there is a relationship between two phenomena (e.g. that a potential treatment has a measurable effect)—is a central task in the modern practice of science; the field of statistics gives precise criteria for rejecting a null hypothesis.

A null hypothesis is a precise statement about a population that we try to reject with sample data.

We don't usually believe our null hypothesis (or H0) to be true. However, we need some exact statement as a starting point for statistical significance testing.



Null Hypothesis Examples

Often -but not always- the null hypothesis states there is no association or difference between variables or subpopulations. Like so, some typical null hypotheses are:

- The correlation between frustration and aggression is zero (correlation-analysis);
- The average income for men is similar to that for women (independent samples t-test);
- Nationality is (perfectly) unrelated to music preference (chi-square independence test);
- The average population income was equal over 2012 through 2016 (repeated measures ANOVA).

"Null" Does Not Mean "Zero"

A common misunderstanding is that "null" implies "zero". This is often but not always the case. For example, a null hypothesis may also state that

The correlation between frustration and aggresion is 0.5.

No zero involved here and -although somewhat unusual- perfectly valid.

The "null" in "null hypothesis" derives from "nullify": the null hypothesis is the statement that we're trying to refute, regardless whether it does (not) specify a zero effect.

Null Hypothesis – Limitations

Thus far, we only concluded that the population correlation is probably not zero. That's the only conclusion from our null hypothesis approach and it's not really that interesting.

What we really want to know is the population correlation. Our sample correlation of 0.25 seems a reasonable estimate. We call such a single number a point estimate.

Now, a new sample may come up with a different correlation. An interesting question is how much our sample correlations would fluctuate over samples if we'd draw many of them. The figure below shows precisely that, assuming our sample size of N = 100 and our (point) estimate of 0.25 for the population correlation.

Framing Alternative Hypothesis

An alternative hypothesis is one in which a difference (or an effect) between two or more variables is anticipated by the researchers; that is, the observed pattern of the data is not due to a chance occurrence. This follows from the tenets of science, in which empirical evidence must be found to refute the null hypothesis before one can claim support for an alternative hypothesis (i.e. there is in fact a reliable difference or effect in whatever is being studied). The concept of the alternative hypothesis is a central part of formal hypothesis testing.

An alternative hypothesis states that there is statistical significance between two variables. In the earlier example, the two variables are Mentos and Diet Coke. The alternative hypothesis is the hypothesis that the researcher is trying to prove. In the Mentos and Diet Coke experiment, Arnold was trying to prove that the Diet Coke would explode if he put Mentos in the bottle. Therefore, he proved his alternative hypothesis was correct.

The alternative hypothesis is generally denoted as H1. It makes a statement that suggests or advises a potential result or an outcome that an investigator or the researcher may expect. It has been categorized into two categories: directional alternative hypothesis and non-directional alternative hypothesis.

Key Differences between Null and Alternative Hypothesis

The important points of differences between null and alternative hypothesis are explained as under:-

1. A null hypothesis is a statement, in which there is no relationship between two variables. An alternative hypothesis is a statement; that is simply the inverse of the null hypothesis, i.e. there is some statistical significance between two measured phenomenon.
2. A null hypothesis is what, the researcher tries to disprove whereas an alternative hypothesis is what the researcher wants to prove.
3. A null hypothesis represents, no observed effect whereas an alternative hypothesis reflects, some observed effect.
4. If the null hypothesis is accepted, no changes will be made in the opinions or actions. Conversely, if the alternative hypothesis is accepted, it will result in the changes in the opinions or actions.
5. As null hypothesis refers to population parameter, the testing is indirect and implicit. On the other hand, the alternative hypothesis indicates sample statistic, wherein, the testing is direct and explicit.

6. A null hypothesis is labelled as H0 (H-zero) while an alternative hypothesis is represented by H1 (H-one).
7. The mathematical formulation of a null hypothesis is an equal sign but for an alternative hypothesis is not equal to sign.
8. In null hypothesis, the observations are the outcome of chance whereas, in the case of the alternative hypothesis, the observations are an outcome of real effect.

Conclusion

There are two outcomes of a statistical test, i.e. first, a null hypothesis is rejected and alternative hypothesis is accepted, second, null hypothesis is accepted, on the basis of the evidence. In simple terms, a null hypothesis is just opposite of alternative hypothesis.

Concept of Hypothesis Testing: Logic and Importance

Hypothesis Testing

Hypothesis testing was introduced by Ronald Fisher, Jerzy Neyman, Karl Pearson and Pearson's son, Egon Pearson. Hypothesis testing is a statistical method that is used in making statistical decisions using experimental data. Hypothesis Testing is basically an assumption that we make about the population parameter.

Hypothesis Testing is done to help determine if the variation between or among groups of data is due to true variation or if it is the result of sample variation. With the help of sample data we form assumptions about the population, then we have to test our assumptions statistically. This is called Hypothesis testing.

Key terms and concepts:

(i) Null hypothesis: Null hypothesis is a statistical hypothesis that assumes that the observation is due to a chance factor. Null hypothesis is denoted by; H0: μ1 = μ2, which shows that there is no difference between the two population means.

(ii) Alternative hypothesis: Contrary to the null hypothesis, the alternative hypothesis shows that observations are the result of a real effect.

(iii) Level of significance: Refers to the degree of significance in which we accept or reject the null-hypothesis. 100% accuracy is not possible for accepting or rejecting a hypothesis, so we therefore select a level of significance that is usually 5%.

(iv) Type I error: When we reject the null hypothesis, although that hypothesis was true. Type I error is denoted by alpha. In hypothesis testing, the normal curve that shows the critical region is called the alpha region.

(v) Type II errors: When we accept the null hypothesis but it is false. Type II errors are denoted by beta. In Hypothesis testing, the normal curve that shows the acceptance region is called the beta region.

(vi) Power: Usually known as the probability of correctly accepting the null hypothesis. 1-beta is called power of the analysis.

(vii) One-tailed test: When the given statistical hypothesis is one value like H0: μ1 = μ2, it is called the one-tailed test.

(viii) Two-tailed test: When the given statistics hypothesis assumes a less than or greater than value, it is called the two-tailed test.

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Importance of Hypothesis Testing

Hypothesis testing is one of the most important concepts in statistics because it is how you decide if something really happened, or if certain treatments have positive effects, or if groups differ from each other or if one variable predicts another. In short, you want to proof if your data is statistically significant and unlikely to have occurred by chance alone. In essence then, a hypothesis test is a test of significance.

Possible Conclusions

Once the statistics are collected and you test your hypothesis against the likelihood of chance, you draw your final conclusion. If you reject the null hypothesis, you are claiming that your

result is statistically significant and that it did not happen by luck or chance. As such, the outcome proves the alternative hypothesis. If you fail to reject the null hypothesis, you must conclude that you did not find an effect or difference in your study. This method is how many pharmaceutical drugs and medical procedures are tested.

T-Test (Mean, Proportion)

The t test is one type of inferential statistics. It is used to determine whether there is a significant difference between the means of two groups. With all inferential statistics, we assume the dependent variable fits a normal distribution. When we assume a normal distribution exists, we can identify the probability of a particular outcome. We specify the level of probability (alpha level, level of significance, p) we are willing to accept before we collect data ($p < .05$ is a common value that is used). After we collect data we calculate a test statistic with a formula. We compare our test statistic with a critical value found on a table to see if our results fall within the acceptable level of probability.

When the difference between two population averages is being investigated, a t test is used. In other words, a t test is used when we wish to compare two means (the scores must be measured on an interval or ratio measurement scale). We would use a t test if we wished to compare the reading achievement of boys and girls. With a t test, we have one independent variable and one dependent variable. The independent variable (gender in this case) can only have two levels (male and female). The dependent variable would be reading achievement. If the independent had more than two levels, then we would use a one-way analysis of variance (ANOVA).

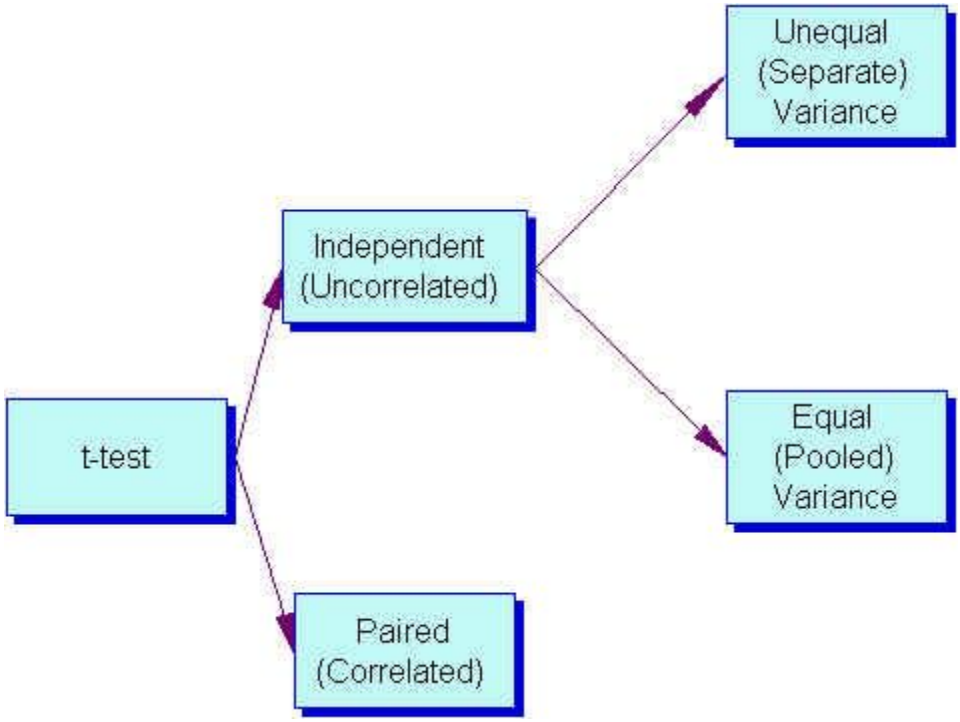
The test statistic that a t test produces is a t-value. Conceptually, t-values are an extension of z-scores. In a way, the t-value represents how many standard units the means of the two groups are apart.

With a t test, the researcher wants to state with some degree of confidence that the obtained difference between the means of the sample groups is too great to be a chance event and that some difference also exists in the population from which the sample was drawn. In other words, the difference that we might find between the boys' and girls' reading achievement in our sample might have occurred by chance, or it might exist in the population. If our t test produces a t-value that results in a probability of .01, we say that the likelihood of getting the difference we found by chance would be 1 in a 100 times. We could say that it is unlikely that our results occurred by chance and the difference we found in the sample probably exists in the populations from which it was drawn.

ASSUMPTIONS UNDERLYING THE T TEST

- The samples have been randomly drawn from their respective populations
- The scores in the population are normally distributed
- The scores in the populations have the same variance (s1=s2) Note: We use a different calculation for the standard error if they are not.

THREE TYPES OF T TESTS



1. Pair-difference t test (a.k.a. t-test for dependent groups, correlated t test) df= n (number of pairs) -1

   This is concerned with the difference between the average scores of a single sample of individuals who are assessed at two different times (such as before treatment and after treatment). It can also compare average scores of samples of individuals who are paired in some way (such as siblings, mothers, daughters, persons who are matched in terms of a particular characteristics).

2. t test for Independent Samples (with two options)

   This is concerned with the difference between the averages of two populations. Basically, the procedure compares the averages of two samples that were selected independently of each other, and asks whether those sample averages differ enough to believe that the populations from which they were selected also have different averages. An example would be comparing math achievement scores of an experimental group with a control group.

- Equal Variance (Pooled-variance t-test) df=n (total of both groups) -2 Note: Used when both samples have the same number of subject or when s1=s2 (Levene or F-max tests have p > .05).
- Unequal Variance (Separate-variance t test) df dependents on a formula, but a rough estimate is one less than the smallest group Note: Used when the samples have different numbers of subjects and they have different variances — s1<>s2 (Levene or F-max tests have p < .05).

F- Test, Z – Test

Z – test

T – test

F – test

Hypothesis Testing

Situation	Decision	
	Accept Null	Reject Null
Null is true	Correct	Type I error (α error)
Null is false	Type II error (β error)	Correct

F- TEST

An F-test is any statistical test in which the test statistic has an F-distribution under the null hypothesis. It is most often used when comparing statistical models that have been fitted to a data set, in order to identify the model that best fits the population from which the data were sampled. Exact "F-tests" mainly arise when the models have been fitted to the data using least squares. The name was coined by George W. Snedecor, in honour of Sir Ronald A. Fisher. Fisher initially developed the statistic as the variance ratio in the 1920s

Assumptions of F- Test

Several assumptions are made for the test. Your population must be approximately normally distributed (i.e. fit the shape of a bell curve) in order to use the test. Plus, the samples must be independent events. In addition, you'll want to bear in mind a few important points:-

- The larger variance should always go in the numerator (the top number) to force the test into a right-tailed test. Right-tailed tests are easier to calculate.
- For two-tailed tests, divide alpha by 2 before finding the right critical value.
- If you are given standard deviations, they must be squared to get the variances.
- If your degrees of freedom aren't listed in the F Table, use the larger critical value. This helps to avoid the possibility of Type I errors.

Common examples

Common examples of the use of F-tests include the study of the following cases:

- The hypothesis that the means of a given set of normally distributed populations, all having the same standard deviation, are equal. This is perhaps the best-known F-test, and plays an important role in the analysis of variance (ANOVA).
- The hypothesis that a proposed regression model fits the data well. See Lack-of-fit sum of squares.
- The hypothesis that a data set in a regression analysis follows the simpler of two proposed linear models that are nested within each other.

F Test to compare two variances by hand: Steps

Warning: F tests can get really tedious to calculate by hand, especially if you have to calculate the variances. You're much better off using technology (like Excel — see below).

These are the general steps to follow. Scroll down for a specific example (watch the video underneath the steps).

Step 1: If you are given standard deviations, go to Step 2. If you are given variances to compare, go to Step 3.

Step 2: Square both standard deviations to get the variances. For example, if σ1 = 9.6 and σ2 = 10.9, then the variances (s1 and s2) would be 9.62 = 92.16 and 10.92 = 118.81.

Step 3: Take the largest variance, and divide it by the smallest variance to get the f-value. For example, if your two variances were s1 = 2.5 and s2 = 9.4, divide 9.4 / 2.5 = 3.76.

Why? Placing the largest variance on top will force the F-test into a right tailed test, which is much easier to calculate than a left-tailed test.

Step 4: Find your degrees of freedom. Degrees of freedom is your sample size minus 1. As you have two samples (variance 1 and variance 2), you'll have two degrees of freedom: one for the numerator and one for the denominator.

Step 5: Look at the f-value you calculated in Step 3 in the f-table. Note that there are several tables, so you'll need to locate the right table for your alpha level. Unsure how to read an f-table? Read What is an f-table?.

Step 6: Compare your calculated value (Step 3) with the table f-value in Step 5. If the f-table value is smaller than the calculated value, you can reject the null hypothesis.

Z-TEST

A Z-test is any statistical test for which the distribution of the test statistic under the null hypothesis can be approximated by a normal distribution. Because of the central limit theorem, many test statistics are approximately normally distributed for large samples. For each significance level, the Z-test has a single critical value (for example, 1.96 for 5% two tailed) which makes it more convenient than the Student's t-test which has separate critical values for each sample size. Therefore, many statistical tests can be conveniently performed as approximate Z-tests if the sample size is large or the population variance is known. If the population variance is unknown (and therefore has to be estimated from the sample itself) and the sample size is not large ($n < 30$), the Student's t-test may be more appropriate.

A one-sample location test, two-sample location test, paired difference test and maximum likelihood estimate are examples of tests that can be conducted as z-tests. Z-tests are closely related to t-tests, but t-tests are best performed when an experiment has a small sample size. Also, t-tests assume the standard deviation is unknown, while z-tests assume it is known. If the standard deviation of the population is unknown, the assumption of the sample variance equaling the population variance is made.

One-Sample Z-Test Example

For example, assume an investor wishes to test whether the average daily return of a stock is greater than 1%. A simple random sample of 50 returns is calculated and has an average of 2%. Assume the standard deviation of the returns is 2.50%. Therefore, the null hypothesis is when the average, or mean, is equal to 3%. Conversely, the alternative hypothesis is whether the mean return is greater than 3%. Assume an alpha of 0.05% is selected with a two-tailed test. Consequently, there is 0.025% of the samples in each tail, and the alpha has a critical value of 1.96 or -1.96. If the value of z is greater than 1.96 or less than -1.96, the null hypothesis is rejected.

The value for z is calculated by subtracting the value of the average daily return selected for the test, or 1% in this case, from the observed average of the samples. Next, divide the resulting value by the standard deviation divided by the square root of the number of observed values. Therefore, the test statistic is calculated to be 2.83, or (0.02 – 0.01) / (0.025 / (50)^(1/2)). The investor rejects the null hypothesis since z is greater than 1.96, and concludes that the average daily return is greater than 1%.

Cross Tabulation, Chi-Squared Test

Cross Tabulation is a main frame statistical model which follows on similar lines, it help you take informed decision with regards to your research by identifying patterns, trends and correlation between parameters within your study. When conducting a study, the raw data can usually be daunting and will always points to several chaotic possible outcomes, in such situation cross-tab helps you zero in on a single theory beyond doubt by drawing trends, comparisons and correlations between factors that are mutually inclusive within your study.

For example, consider your college application – you probably did not realize it at the time but you were mentally cross tabulating the factors involved to arrive at a conscious decision with respect to which colleges you wanted to attend and had the best shot at while applying. Let us go through your decision making process one factor at a time.

First, you needed to look at the academic factor which were your grades throughout high school, SAT scores, the field you wanted to major in and the application essay you would need to write. Second, comes the financial factor which will look at the tuition fees and possibilities of a scholarship. Last, but definitely not the least, would be the emotional factor which will consider your distance from home and how far are the universities your friends are considering so reunions would not be an issue. In other words, cross tabulating Academics + Finance + Emotions led you to a refined list of universities one of which is or soon will be your Alma Mater.

Cross tabulation also known as cross-tab or contingency table is a statistical tool that is used for categorical data. Categorical data involves values that are mutually exclusive to each other. Data is always collected in numbers, but numbers have no value unless they mean something. 4,7,9 are simply numerical unless until specified. For example, 4 apples, 7 bananas, and 9 kiwis.

Cross tabulation is usually used to examine the relationship within the data that is not evident. It is quite useful in market research studies and in surveys. A cross tab report shows the connection between two or more question asked in the survey.

Understanding Cross Tabulation with Example

Cross-tab is a popular choice for statistical data analysis. Since it is a reporting/ analyzing tool it can used with any level of data: ordinal or nominal, because it treats all data as nominal data (nominal data is not measured it is categorized).

Let's say you can analyze the relation between two categorical variable like age and purchase of electronic gadgets.

There are two questions asked here:

(i) What is your age?

(ii) What is the electronic gadget that you are likely to buy in the next 6 months?

Age	Laptop	Phone	Tablet	Digital Camera
20-25	38%	29%	31%	12%
25-30	19%	15%	24%	17%
30-35	23%	19%	11%	27%
35-40	19%	12%	9%	30%
Above 40	12%	17%	5%	31%

In this example you can see the distinctive connection between the age and the purchase of the electronic gadget. It is not surprising but certainly interesting to see the correlation between the two variables through the data collected.

In survey research crosstab allows to deep dive and analyze the prospective data, making it simpler to spot trends and opportunities without getting overwhelmed with all the data gathered from the responses.

Chi-Squared Test

A chi-squared test, also written as $\chi 2$ test, is any statistical hypothesis test where the sampling distribution of the test statistic is a chi-squared distribution when the null hypothesis is true. Without other qualification, 'chi-squared test' often is used as short for Pearson's chi-squared test. The chi-squared test is used to determine

whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories.

In the standard applications of the test, the observations are classified into mutually exclusive classes, and there is some theory, or say null hypothesis, which gives the probability that any observation falls into the corresponding class. The purpose of the test is to evaluate how likely the observations that are made would be, assuming the null hypothesis is true.

Chi-squared tests are often constructed from a sum of squared errors, or through the sample variance. Test statistics that follow a chi-squared distribution arise from an assumption of independent normally distributed data, which is valid in many cases due to the central limit theorem. A chi-squared test can be used to attempt rejection of the null hypothesis that the data are independent.

How to Calculate a Chi-square Statistics?

The formula for calculating a Chi-square statistic is:

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

Where,

O stands for the observed frequency,

E stands for the expected frequency.

Expected count is subtracted from the observed count to find the difference between the two. Then the square of the difference is calculated to get rid of the negative vales (as the squares of 2 and −2 are, of course, both 4). Then the square of the difference is divided by the expected count to normalize bigger and smaller values (because we don't want to get bigger Chi-square values just because we are working on large data sets). The sigma sign in front of them denotes that we have, to sum up, these values calculated for each cell.

As an example, suppose we want to find out that whether there is an association between smoking and lung disease.

The null and alternative hypothesis will be:-

H 0 : There is no association between smoking and lung disease.

H 1 : There is an association between smoking and lung disease.

Analysis of Variance: One Way and Two Way Classifications

Analysis of Variance

Analysis of Variance (ANOVA) is a parametric statistical technique used to compare datasets. This technique was invented by R.A. Fisher, and is thus often referred to as Fisher's ANOVA, as well. It is similar in application to techniques such as t-test and z-test, in that it is used to compare means and the relative variance between them. However, analysis of variance (ANOVA) is best applied where more than 2 populations or samples are meant to be compared.

Analysis of variance (ANOVA) is a collection of statistical models and their associated estimation procedures (such as the "variation" among and between groups) used to analyze the differences among group means in a sample. ANOVA was developed by statistician and evolutionary biologist Ronald Fisher. In the ANOVA setting, the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form, ANOVA provides a statistical test of whether the population means of several groups are equal, and therefore generalizes the t-test to more than two groups. ANOVA is useful for comparing

(testing) three or more group means for statistical significance. It is conceptually similar to multiple two-sample t-tests, but is more conservative, resulting in fewer type I errors, and is therefore suited to a wide range of practical problems.

The Formula for ANOVA

The following formula represents a one-way ANOVA test:

ANOVA formula

F= MST/MSE

Where:

F = ANOVA coefficient

MST = Mean sum of squares due to treatment

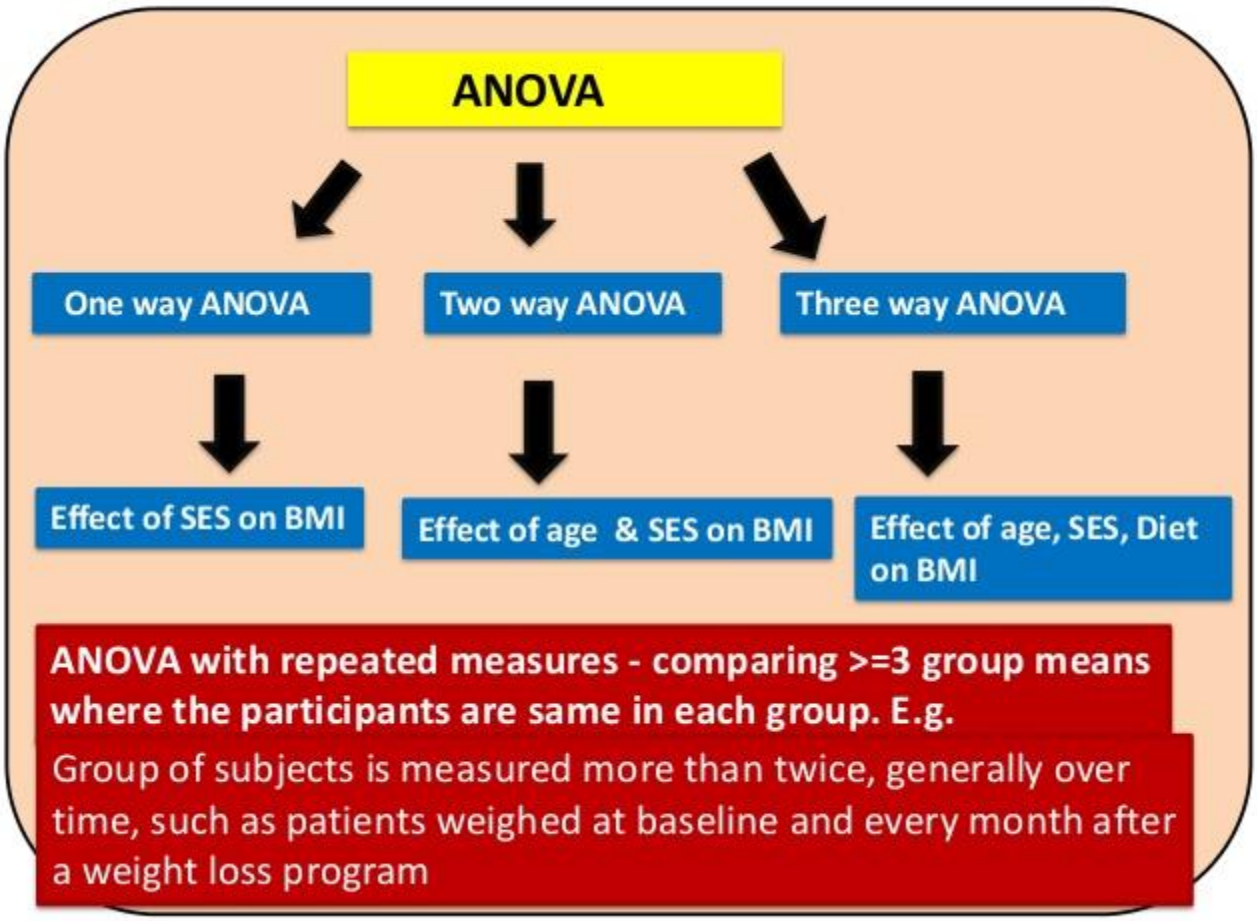
MSE = Mean sum of squares due to error.

Example of How to Use ANOVA

A researcher might, for example, test students from multiple colleges to see if students from one of the colleges consistently outperform students from the other schools. In a business application, an R&D researcher might test two different processes of creating a product to see if one process is better than the other in terms of cost efficiency.

The type of ANOVA run depends on a number of factors. It is applied when data needs to be experimental. Analysis of variance is employed if there is no access to statistical software resulting in computing ANOVA by hand. It is simple to use and best suited for small samples. With many experimental designs, the sample sizes have to be the same for the various factor level combinations.

Analysis of variances is helpful for testing three or more variables. It is similar to multiple two-sample t-tests. However, it results in fewer type I errors and is appropriate for a range of issues. ANOVA groups differences by comparing the means of each group, and includes spreading out the variance into diverse sources. It is employed with subjects, test groups, between groups and within groups.



ONE-WAY ANOVA

A one-way ANOVA is a type of statistical test that compares the variance in the group means within a sample whilst considering only one independent variable or factor. It is a hypothesis-based test, meaning that it aims to evaluate multiple mutually exclusive theories about our data. Before we can generate a hypothesis, we need to have a question about our data that we want an answer to. For example, adventurous researchers studying a population of walruses might ask "Do our walruses weigh more in early or late mating season?" Here, the independent variable or factor (the two terms mean the same thing) is "month of mating season". In an ANOVA, our independent variables are organized in categorical groups. For example, if the researchers looked at walrus weight in December, January, February and March, there would be four months analyzed, and therefore four groups to the analysis.

A one-way ANOVA compares three or more than three categorical groups to establish whether there is a difference between them. Within each group there should be three or more observations (here, this means walruses), and the means of the samples are compared.

Hypotheses of One-Way ANOVA

In a one-way ANOVA there are two possible hypotheses.

- The null hypothesis (H0) is that there is no difference between the groups and equality between means. (Walruses weigh the same in different months)
- The alternative hypothesis (H1) is that there is a difference between the means and groups. (Walruses have different weights in different months)

Assumptions of One-Way ANOVA

- **Normality –** That each sample is taken from a normally distributed population
- **Sample independence –** that each sample has been drawn independently of the other samples
- **Variance Equality –** That the variance of data in the different groups should be the same

- **Your dependent variable –** here, “weight”, should be continuous – that is, measured on a scale which can be subdivided using increments (i.e. grams, milligrams)

TWO-WAY ANOVA

Two-way ANOVA is, like a one-way ANOVA, a hypothesis-based test. However, in the two-way ANOVA each sample is defined in two ways, and resultingly put into two categorical groups. Thinking again of our walruses, researchers might use a two-way ANOVA if their question is: “Are walruses heavier in early or late mating season and does that depend on the gender of the walrus?” In this example, both “month in mating season” and “gender of walrus” are factors – meaning in total, there are two factors. Once again, each factor’s number of groups must be considered – for “gender” there will only two groups “male” and “female”.

The two-way ANOVA therefore examines the effect of two factors (month and gender) on a dependent variable – in this case weight, and also examines whether the two factors affect each other to influence the continuous variable.

Assumptions of Two-Way ANOVA

- **Your dependent variable –** Here, “weight”, should be continuous – that is, measured on a scale which can be subdivided using increments (i.e. grams, milligrams)
- **Your two independent variables –** Here, “month” and “gender”, should be in categorical, independent groups.
- **Sample independence –** That each sample has been drawn independently of the other samples.
- **Variance Equality –** That the variance of data in the different groups should be the same.
- **Normality –** That each sample is taken from a normally distributed population.

Hypotheses of Two-Way ANOVA

Because the two-way ANOVA consider the effect of two categorical factors, and the effect of the categorical factors on each other, there are three pairs of null or alternative hypotheses for the two-way ANOVA. Here, we present them for our walrus experiment, where month of mating season and gender are the two independent variables.

H0: The means of all month groups are equal

H1: The mean of at least one month group is different.

H0: The means of the gender groups are equal.

H1: The means of the gender groups are different.

H0: There is no interaction between the month and gender.

H1: There is interaction between the month and gender.

Summary: Differences between One-Way and Two-Way ANOVA

The key differences between one-way and two-way ANOVA are summarized clearly below.

1. A one-way ANOVA is primarily designed to enable the equality testing between three or more means. A two-way ANOVA is designed to assess the interrelationship of two independent variables on a dependent variable.
2. A one-way ANOVA only involves one factor or independent variable, whereas there are two independent variables in a two-way ANOVA.
3. In a one-way ANOVA, the one factor or independent variable analyzed has three or more categorical groups. A two-way ANOVA instead compares multiple groups of two factors.
4. One-way ANOVA need to satisfy only two principles of design of experiments, i.e. replication and randomization. As opposed to Two-way ANOVA, which meets all three principles of design of experiments which are replication, randomization, and local control.