Research Methodology

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Research Methodology

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Foreword

Students in higher education will at least once meet a task during their studies in which they are required to synthesize their knowledge about a given topic or topic area in a written form, elaborate on their views, opinions, and thoughts.

This coursebook provides guidelines on how to prepare a study, from concept forming through the publishing of the ready-made paper. By getting acquainted with the process of the research activity, the readers can gain insight into the techniques of gathering background materials, note-taking, and they can familiarize themselves with various methods of research and data analysis.

The first chapter of the coursebook gives a brief introduction to the structure of research plan, particular research methods, the importance of sampling, and data collection. In the statistical analysis of data my aim was not to demonstrate the complete theoretical background and structure, rather to provide insight into how to use the SPSS program through presenting practical applications. The coursebook presents the particular analyses (hypothesis testing, univariate statistical analyses, cross-tab analysis, analysis of variance, correlation and regression analysis) through sample tasks, which the readers can follow through in practice providing that they download the datafiles and have an SPSS software program package. The last chapters are about presenting results, and preparing a written report. At the end of each chapter there is a bibliography of the relevant readings, whose study allows readers to expand their knowledge. There are also concluding questions for readers to test their knowledge on the topic in question.

However, the research methodology presented here can only provide some information and orientation, as there is no single proven method which would present us with a ready-made paper without having to invest much effort. Nevertheless, the methods demonstrated in the coursebook can help the readers prepare any study faster, more easily, and with greater efficiency.

I am aware of the fact that I have not been able to meet my objectives in every respect. However, if some advance has been made in bringing research methodology closer to agricultural engineers, as well as in presenting a comprehensive but at the same time still learnable toolkit of research methodology which they can rely on when writing a study, my efforts were not in vain.

The Editor
1. fejezet - 1. Basic Research Terminology

1. 1.1 Research

Research is the systematic process of collecting and analyzing information to increase our understanding of the phenomenon under study. It is the function of the researcher to contribute to the understanding of the phenomenon and to communicate that understanding to others.

Research may be defined as a systematic approach/method consisting of enunciating the problem, formulating a hypothesis, collecting the facts or data, analyzing the facts and reaching certain conclusions, either in the form of solution towards the concerned problem or in certain generalizations for some theoretical formulation. Research may also be defined as a scientific study, which by means of logical and systematized techniques, aims to:

1. Discover new facts or verify and test old facts,
2. Analyze their sequences, inter-relationships and explanations which are derived within an appropriate theoretical frame of reference,
3. Develop new scientific tools, concepts, and theories which would facilitate reliable and valid study of human behavior in decision making.

2. 1.2 Purpose of Research

The purpose of research can be a complicated issue and varies across different scientific fields and disciplines. At the most basic level, science can be split, loosely, into two types, ‘pure research’ and ‘applied research’. Both of these types follow the same structures and protocols for propagating and testing hypotheses and predictions, but vary slightly in their ultimate purpose. An excellent example for illustrating the difference is by using pure and applied mathematics. Scientific research relies on the application of the scientific method, a harnessing of curiosity. This research provides scientific information and theories for the explanation of the nature and the properties of the world. It makes practical applications possible. Scientific research is funded by public authorities, by charitable organizations and by private groups, including many companies. Scientific research can be subdivided into different classifications according to their academic and application disciplines.

2.1. 1.2.1 Objectives of research

The following are the objectives of Research:

1. Academic Objectives: To gain familiarity with a phenomenon or to achieve new insights into it. The Academic object of research is the acquisition of knowledge and it is the thirst for knowledge couple with curiosity that has been the guiding force behind a rich variety of research work independent of any material incentive.

2. Utilitarian objectives: The primary goal of research, immediate or distant, is to understand the organizational culture, social life, social environment, decision making processes etc and thereby gain a greater measure of control over human behavior in the organization and social context.

3. Research helps in portraying accurately the characteristics of a particular individual, situation or a group in the organization and leads to organization redesign, and design of strategies of development.

4. Research may be used to determine the frequency with which a certain thing occurs or with which it is associated with something else.

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1 wps.prenhall.com/chet_leedy_practical_8/0,9599,1569572,-00.html
2 www.iilm.edu/iilm-online/research-methodology.html
3 explorable.com/purpose-of-research
5. It helps in testing a hypothesis or a casual relationship between variables.

### 2.2. 1.2.2 Pure Scientific Research

Some science, often referred to as ‘pure science’, is about explaining the world around us and trying to understand how the universe operates. It is about finding out what is already there without any greater purpose of research than the explanation itself. It is a direct descendent of philosophy, where philosophers and scientists try to understand the underlying principles of existence.

Whilst offering no direct benefits, pure research often has indirect benefits, which can contribute greatly to the advancement of humanity.

### 2.3. 1.2.3 Applied Scientific Research

Applied scientists might look for answers to specific questions that help humanity, for example medical research or environmental studies. Such research generally takes a specific question and tries to find a definitive and comprehensive answer.

The purpose of research is about testing theories, often generated by pure science, and applying them to real situations, addressing more than just abstract principles.

Applied scientific research can be about finding out the answer to a specific problem.

### 3. 1.3 Research Methods

The Research methods may be defined as all those methods/techniques that are used for conducting the research. Research methods can be put into the following three groups:

1. In the first group, we include those methods which are concerned with the collection of data, these methods will be used where the data already available are not sufficient to arrive at the required solution.

2. The second group consists of those Statistical Techniques which are used for establishing relationships between variables.

3. The third group consists of those methods which are used to evaluate the accuracy of the results obtained.

### 4. 1.4 Research Methodology

Research methodology may be defined as a way to systematically solve the research problem. Research methodology constitutes of research methods, selection criterion of research methods, used in context of research study and explanation of using of a particular method or technique and why other techniques are not used so that research results are capable of being evaluated either by researcher himself or by others.

#### 4.1. 1.4.1 The Significance of Research Methodology

By knowing all of the aforementioned one has to be able to read, think, write and speak in a different way (Table 1).

#### 1. táblázat - Table 1. The Significance of Research Process

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<th>General Research Methodology</th>
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* explorable.com/purpose-of-research
* http://explorable.com/purpose-of-research
* explorable.com/purpose-of-research
* en.wikipedia.org/wiki/Research
### 1. Basic Research Terminology

<table>
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<tr>
<th>Reading</th>
<th>Thinking</th>
<th>Writing, Speaking</th>
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<tr>
<td>Researching and documenting special literature</td>
<td>Logistic-heuristic methods</td>
<td>Statement and complication of texts</td>
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<tr>
<td>Novelty can be proven only by discriminating it from existing information</td>
<td>Information analysis and creative method</td>
<td>Using jargon</td>
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<td></td>
<td>Heuristic technique of creative knowledge enhancement</td>
<td>Composing texts</td>
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<tr>
<td></td>
<td>Hypotheses, their study, and methods of output evaluation</td>
<td>Structuring writing</td>
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### 5. 1.5 Research Process\(^\text{11}\)

Research process consists of a series of actions or steps necessary to effectively carry out research and the desired sequencing of these steps. These are as follows (Figure 1).

**1.1. ábra - Figure 1. Stages of the Research Process**

Complided from various sources

#### 5.1. 1.5.1 Formulating the research problem

In research, the foremost step that comes into play is that of defining the research problem and it becomes almost a necessity to have the basic knowledge and understanding of most of its elements as this would help a lot in making a correct decision. The research problem can be said to be complete only if it is able to specify

about the unit of analysis, time and space boundaries, features that are under study, specific environmental conditions that are present in addition to prerequisite of the research process\(^\text{12}\).

### 5.2. 1.5.2 Extensive literature survey

A literature review usually precedes a research proposal and results section. Its main goals are to situate the current study within the body of literature and to provide context for the particular reader\(^\text{13}\).

### 5.3. 1.5.3 Developing the hypothesis

Research hypotheses are the specific testable predictions made about the independent and dependent variables in the study. Usually the literature review has given background material that justifies the particular hypotheses that are to be tested. Hypotheses are couched in terms of the particular independent and dependent variables that are going to be used in the study\(^\text{14}\).

### 5.4. 1.5.4 Determining sample design

When conducting research, it is almost always impossible to study the entire population that you are interested in. For example, if you were studying political views among college students in the Hungary, it would be nearly impossible to survey every single college student across the country. If you were to survey the entire population, it would be extremely timely and costly. As a result, researchers use samples as a way to gather data\(^\text{15}\).

### 5.5. 1.5.5 Collecting the data

Data collection is any process of preparing and collecting data, for example, as part of a process improvement or similar project. The purpose of data collection is to obtain information to keep on record, to make decisions about important issues, or to pass information on to others. Data are primarily collected to provide information regarding a specific topic\(^\text{16}\).

### 5.6. 1.5.6 Execution of the project

After the researcher has collected the data, the next step in the research process is the execution of the project (i.e., implementation phase of the project). This step is very important in the research process as it ensures that the research is being executed systematically and in time. If the execution of the research proceeds on correct lines, then the collected data would be adequate and dependable\(^\text{17}\).

### 5.7. 1.5.7 Analysis of data

Analysis of data is a process of inspecting, cleaning, transforming, and modeling data with the goal of highlighting useful information, suggesting conclusions, and supporting decision making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, in different business, science, and social science domains\(^\text{18}\).

### 5.8. 1.5.8 Hypothesis testing

A researcher uses hypothesis testing to support beliefs about comparisons (i.e., variables or groups). Basically, it is how we empirically test our research hypotheses for ‘accuracy’. We never prove beyond the shadow of a doubt that a comparison is true. Rather, we conclude that, based on some collected data and assumptions, the probability of the comparison being true is very high (i.e., around 95 – 99% sure)\(^\text{19}\). In all hypothesis testing, the

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\(^{13}\) [en.wikipedia.org/wiki/Literature_review](http://en.wikipedia.org/wiki/Literature_review)

\(^{14}\) [www.public.asu.edu/~kroel/www500/hypothesis.pdf](http://www.public.asu.edu/~kroel/www500/hypothesis.pdf)


\(^{17}\) [blog.reseapro.com/2012/07/execution-of-the-project/](http://blog.reseapro.com/2012/07/execution-of-the-project/)


\(^{19}\) [faculty.txwes.edu/mskerr/files/2420/Ch8_2420.htm](http://faculty.txwes.edu/mskerr/files/2420/Ch8_2420.htm)
hypothesis being tested is a hypothesis about equality. The researcher thinks the equality hypothesis is not true, and by showing how the data do not fit it, the equality hypothesis can be rejected\(^a\).

### 5.9. 1.5.9 Generalization and interpretation

After collecting and analyzing the data, the researcher has to accomplish the task of drawing inferences followed by report writing. This has to be done very carefully, otherwise incorrect conclusions may be drawn and the whole purpose of doing research may get vitiated. It is only through interpretation that the researcher can expose relations and processes that underlie his findings\(^b\).

### 5.10. 1.5.10 Preparation of the report

Oral presentation of the report is the final stage of the research, and its purpose is to convey to the intended audience the whole result of the study in sufficient details and to enable each user of research to comprehend the data and to determine for himself the validity of the conclusion\(^c\).

### 6. References and further reading

8. Execution of the Project: blog.reseapro.com/2012/07/execution-of-the-project/
12. Literature review: en.wikipedia.org/wiki/Literature_review
13. Purpose of Research: explorable.com/purpose-of-research
17. Types Of Sampling Designs: sociology.about.com/od/Research/a/sampling-designs.htm
18. What is Research?: wps.prenhall.com/chet_leedy_practical_8/0,9599,1569572-,00.html

7. Questions for Chapter 1

1. What are the fine line difference between discovery, invention and research?

2. What is the difference between Research Methods and Research Methodology?

3. What is the Importance of Research Methodology?

4. What is the difference between Research Process and Research Design?

5. What are the stages of research process?

2. fejezet - 2. Formulating the research problem

1. 2.1 Research problem defined

A research problem is some difficulty either of a theoretical or practical nature which an individual or organization faces and wishes to obtain a solution for the same. A research problem must contain the following:

1. An individual or an organization which has the problem.
2. They must occupy some environment/condition to which the difficulty pertains.
3. Some objective/goal to be attained.
4. Some alternative course of action through which these objectives can be attained.
5. Researcher must have some doubts regarding the selection of possible alternatives.

A research problem is the situation that causes the researcher to feel apprehensive, confused and ill at ease. It is the demarcation of a problem area within a certain context involving the 'who' or 'what', the 'where', the 'when' and the 'whay' of the problem situation.

There are many problem situations that may give rise to research. Three sources usually contribute to problem identification. Own experience or the experience of others may be a source of problem supply. A second source could be scientific literature. You may read about certain findings and notice that a certain field was not covered. This could lead to a research problem. Theories could be a third source. Shortcomings in theories could be researched.

Research can thus be aimed at clarifying or substantiating an existing theory, at clarifying contradictory findings, at correcting a faulty methodology, at correcting the inadequate or unsuitable use of statistical techniques, at reconciling conflicting opinions, or at solving existing practical problems.

2. 2.2 Necessity of defining a research problem

It is important to formulate a research problem properly. In fact, problem formulation is even more essential than its prospective solution. A carefully defined research problem does not let a researcher stray from the research path that should be followed. It is therefore, concluded that only upon a detailed definition of the research problem, the researcher can progress with the design of research methodology. This also leads to a smoother progress on all the subsequent steps that are involved in completing a research project.

3. 2.3 Identification of the problem

The prospective researcher should think on what caused the need to do the research (problem identification). The question that he/she should ask is: Are there questions about this problem to which answers have not been found up to the present?

Research originates from a need that arises. A clear distinction between the problem and the purpose should be made. The problem is the aspect the researcher worries about, think about, wants to find a solution for. The
2. Formulating the research problem

The purpose is to solve the problem, ie find answers to the question(s). If there is no clear problem formulation, the purpose and methods are meaningless.

Keep the following in mind:

1. Outline the general context of the problem area.
2. Highlight key theories, concepts and ideas current in this area.
3. What appear to be some of the underlying assumptions of this area?
4. Why are these issues identified important?
5. What needs to be solved?
6. Read round the area (subject) to get to know the background and to identify unanswered questions or controversies, and/or to identify the the most significant issues for further exploration.

The research problem should be stated in such a way that it would lead to analytical thinking on the part of the researcher with the aim of possible concluding solutions to the stated problem. Research problems can be stated in the form of either questions or statements:

1. The research problem should always be formulated grammatically correct and as completely as possible. You should bear in mind the wording (expressions) you use. Avoid meaningless words. There should be no doubt in the mind of the reader what your intentions are.
2. Demarcating the research field into manageable parts by dividing the main problem into subproblems is of the utmost importance.

4. 2.4 Statement of the problem

The statement of the problem involves the demarcation and formulation of the problem, ie the 'who/what', 'where', 'when', 'whay'. It usually includes the statement of the hypothesis.

A problem statement is a concise description of the issues that need to be addressed by a problem solving team and should be presented to them (or created by them) before they try to solve the problem. When bringing together a team to achieve a particular purpose provide them with a problem statement. A good problem statement should answer these questions:

1. What is the problem? This should explain why the team is needed.
2. Who has the problem or who is the client/customer? This should explain who needs the solution and who will decide the problem has been solved.
3. What form can the resolution be? What is the scope and limitations (in time, money, resources, technologies) that can be used to solve the problem? Does the client want a white paper? A web-tool? A new feature for a product? A brainstorming on a topic?

The primary purpose of a problem statement is to focus the attention of the problem solving team. However, if the focus of the problem is too narrow or the scope of the solution too limited the creativity and innovation of the solution can be stifling.

In project management, the problem statement is part of the project charter. It lists what's essential about the project and enables the project manager to identify the project scope as well as the project stakeholders.
A research-worthy problem statement is the description of an active challenge (i.e. problem) faced by researchers and/or practitioners that does not have adequate solutions available including the argumentation for its viability based on solid peer-reviewed sources as well as theoretical foundation. The research-worthy problem statement should address all six questions: what, how, where, when, why, and who. On the other hand, a statement of the problem is one or two sentences claim that outlines the problem that the study addresses. The statement of the problem should briefly address the question: What is the problem that the research will address? 13

5. 2.5 The grouping of the research problem 14

I. Research problems

1. The need to communicate what will be studied in clear, concise, and unambiguous terms

2. One or more sentences indicating the goal, purpose, or overall direction of the study

3. General characteristics
   a. Implies the possibility of empirical investigation
   b. Identifies a need for the research
   c. Provides focus
   d. Provides a concise overview of the research

4. Two ways of stating the problem
   a. Research problems: typically a rather general overview of the problem with just enough information about the scope and purpose of the study to provide an initial understanding of the research
   b. Research statements and/or questions: more specific, focused statements and questions that communicate in greater detail the nature of the study

5. Researchable and non-researchable problems
   a. Researchable problems imply the possibility of empirical investigation
   b. Non-researchable problems include explanations of how to do something, vague propositions, and value-based concerns

6. Comparing quantitative and qualitative research problems
   a. Quantitative problems
   b. Qualitative problems

7. Sources of research problems
   a. Casual observation
   b. Deductions from theory
   c. Related literature
   d. Current social and political issues
   e. Practical situations
   f. Personal interests and experience

13 en.wikipedia.org/wiki/Problem_statement
14 wps.ablongman.com/ab_mcmillan_edresearch_4/16/4150/1062474.cw/index.html (2.5 Chapter)
2. Formulating the research problem

g. Replication of previous studies
h. Clarification of contradictory research results

II. Quantitative research problems

1. Three types of questions
   a. Descriptive
   b. Relational
   c. Causal

2. Identifies specifically the type of research, the variables and relationships between them, and the subjects

3. Variables
   a. A variable is a label or name that represents a concept or characteristic that varies (e.g., gender, weight, achievement, attitudes toward inclusion, etc.)
   b. Conceptual and operational definitions of variables
      i. Conceptual (i.e., constitutive) definition uses words or concepts to define a variable
      ii. Operational definition is an indication of the meaning of a variable through the specification of the manner by which it is measured, categorized, or controlled
   c. Types of variables
      i. Three variable labels defined by the context within which the variable is discussed
         A. Independent and dependent variables
         B. Extraneous and confounding variables
         C. Continuous and categorical variables
      ii. Independent and dependent (i.e., cause and effect)
         A. Independent variables act as the "cause" in that they precede, influence, and predict the dependent variable
         B. Dependent variables act as the effect in that they change as a result of being influenced by an independent variable
         C. Examples
         D. Some situations do not lend themselves to the use of the terms independent or dependent because it is difficult to discuss them in causal terms
      iii. Extraneous and confounding variables
         A. Extraneous variables are those that affect the dependent variable but are not controlled adequately by the researcher
         B. Confounding variables are those that vary systematically with the independent variable and exert influence of the dependent variable
      iv. Continuous and categorical
         A. Continuous variables are measured on a scale that theoretically can take on an infinite number of values
2. Formulating the research problem

B. Categorical variables are measured and assigned to groups on the basis of specific characteristics

C. Continuous variables can be converted to categorical variables, but categorical variables cannot be converted to continuous variables

6. 2.6 Checklist for testing the feasibility of the research problem

1. Is the problem of current interest? Will the research results have social, educational or scientific value?
2. Will it be possible to apply the results in practice?
3. Does the research contribute to the science of education?
4. Will the research opt new problems and lead to further research?
5. Is the research problem important? Will you be proud of the result?
6. Is there enough scope left within the area of research (field of research)?
7. Can you find an answer to the problem through research? Will you be able to handle the research problem?
8. Will it be practically possible to undertake the research?
9. Will it be possible for another researcher to repeat the research?
10. Is the research free of any ethical problems and limitations?
11. Will it have any value?
12. Do you have the necessary knowledge and skills to do the research? Are you qualified to undertake the research?
13. Is the problem important to you and are you motivated to undertake the research?
14. Is the research viable in your situation? Do you have enough time and energy to complete the project?
15. Do you have the necessary funds for the research?
16. Will you be able to complete the project within the time available?
17. Do you have access to the administrative, statistic and computer facilities the research necessitates?

7. References and further reading


3. Defining the Reseach Problem: explorable.com/defining-a-research-problem


nmuu.ac.za/robert/resprobl.htm (2.6 Chapter)
2. Formulating the research problem


10. Research Problem: nmmu.ac.za/robert/resprobl.htm


12. What is Research Problem?: nmmu.ac.za/robert/resprobl.htm

8. Questions for Chapter 2

1. Define the term research problem and identify three characteristics of good research problems.

2. Differentiate research problems from research problem statements and/or questions.

3. Identify four common sources of research problems.

4. Describe the characteristics of quantitative research problems.

5. State the criteria for evaluating quantitative research problems and evaluate specific problems using these criteria.

6. Differentiate the following types of hypotheses: 1) inductive and deductive and 2) research and statistical. Define the term null hypothesis and discuss its use in a study. Identify examples of each type of hypothesis.

7. Describe the characteristics of a qualitative research problem.
3. fejezet - 3. Extensive literature survey

A literature review is a text written by someone to consider the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources, and as such, do not report any new or original experimental work. Also, a literature review can be interpreted as a review of an abstract accomplishment1.

A literature review is an account of what has been published on a topic by accredited scholars and researchers. Occasionally you will be asked to write one as a separate assignment (sometimes in the form of an annotated bibliography – see the bottom of the next page), but more often it is part of the introduction to an essay, research report, or thesis. In writing the literature review, your purpose is to convey to your reader what knowledge and ideas have been established on a topic, and what their strengths and weaknesses are. As a piece of writing, the literature review must be defined by a guiding concept (e.g., your research objective, the problem or issue you are discussing, or your argumentative thesis). It is not just a descriptive list of the material available, or a set of summaries2.

Besides enlarging your knowledge about the topic, writing a literature review lets you gain and demonstrate skills in two areas:

1. Information seeking: the ability to scan the literature efficiently, using manual or computerized methods, to identify a set of useful articles and books;

2. Critical appraisal: the ability to apply principles of analysis to identify unbiased and valid studies3.

1. 3.1 The literature review

A review of the literature is an essential part of your academic research project. The review is a careful examination of a body of literature pointing toward the answer to your research question4. Literature reviewed typically includes scholarly journals, scholarly books, authoritative databases and primary sources. Sometimes it includes newspapers, magazines, other books, films, and audio and video tapes, and other secondary sources5:

1. Primary sources are the origin of information under study, fundamental documents relating to a particular subject or idea. Often they are first hand accounts written by a witness or researcher at the time of an event or discovery. These may be accessible as physical publications, as publications in electronic databases, or on the Internet.

2. Secondary sources are documents or recordings that relate to or discuss information originally presented elsewhere. These, too, may be accessible as physical objects or electronically in databases or on the Internet.

All good research and writing is guided by a review of the relevant literature. Your literature review will be the mechanism by which your research is viewed as a cumulative process. That makes it an integral component of the scientific process6.

2. 3.2 Mechanics of a Literature Review7

A good literature review requires knowledge of the use of indexes and abstracts, the ability to conduct exhaustive bibliographic searches, ability to organise the collected data meaningfully, describe, critique and relate each source to the subject of the inquiry, and present the organised review logically, and last, but by no means least, to correctly cite all sources mentioned.

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1 en.wikipedia.org/wiki/Literature_review
2 www.writing.utoronto.ca/advice/specific-types-of-writing/literature-review
3 www.writing.utoronto.ca/advice/specific-types-of-writing/literature-review
4 www.uncp.edu/home/acurit/Courses/ResourcesForCourses/LitReview.html
5 www.uncp.edu/home/acurit/Courses/ResourcesForCourses/LitReview.html
6 library.bcu.ac.uk/learner/writingguides/1.04.htm
7 www.uncp.edu/home/acurit/Courses/ResourcesForCourses/LitReview.html (3.2 Chapter)
Your literature review will have two components: a search through the literature and the writing of the review. Obviously, the search is the first step. However, you must remember that you love knowledge and that academic databases can be seductive. Have your research question written down and at hand when you arrive at the computer to search databases or a library catalog. Prepare in advance a plan and a preset time limit.

1. Finding too much? If you find so many citations that there is no end in sight to the number of references you could use, its time to re-evaluate your question. It's too broad.

2. Finding too little? On the other hand, if you can't find much of anything, ask yourself if you're looking in the right area. Your topic is too narrow.

Leading edge research. What if you are trying to research an area that seems never to have been examined before? Be systematic. Look at journals that print abstracts in that subject area to get an overview of the scope of the available literature. Then, your search could start from a general source, such as a book, and work its way from those references to the specific topic you want. Or, you could start with a specific source, such as a research paper, and work from that author's references. There isn't a single best approach.

Take thorough notes. Be sure to write copious notes on everything as you proceed through your research. It's very frustrating when you can't find a reference found earlier that now you want to read in full.

It's not hard to open up a blank text document in WordPad (Windows) or TextEdit (Macintosh) to keep a running set of notes during a computer search session. Just jump back and forth between the Web browser screen and the notepad screen.

Using resources wisely. Practice makes perfect. Learn how and then use the available computer resources properly and efficiently. Log onto the Internet frequently. Visit your research resources regularly. Play with the discipline resources.

Identify publications which print abstracts of articles and books in your subject area. Look for references to papers from which you can identify the most useful journals. Identify those authors who seem to be important in your subject area. Identify keywords in your area of interest to help when you need to narrow and refine database searches. Read online library catalogs to find available holdings. Be sure to write copious notes on everything.

Getting ready to write. Eventually, a broad picture of the literature in your subject area – an overview – will begin to emerge. Then it's time to review your notes and begin to draft your literature review. But, where to start?

Suppose you have several WordPad or TextEdit files full of notes you've written. And a dozen real books and copies of three dozen journal articles. File them on a table and sit down. Turn to your research question. Write it out again at the head of a list of the various keywords and authors that you have uncovered in your search. Do any pairings or groupings pop out at you? You now are structuring or sketching out the literature review which is the first step in writing a research paper, thesis or dissertation.

Writing the lit review. One draft won't cut it. Plan from the outset to write and rewrite. Naturally, you will crave a sense of forward momentum, so don't get bogged down. Don't restrict yourself to writing the review in a linear fashion from start to finish. If one area of the writing is proving difficult, jump to another part.

Edit and rewrite. Your goal is to communicate effectively and efficiently the answer you found to your research question in the literature. Edit your work so it is clear and concise. If you will be writing an abstract and introduction, leave them for the last.

Style and writing guides are worth browsing if you are unsure how to approach writing. Always re-read what you have written. Get someone else to read it. Read it aloud to see how it sounds to your ear. Then revise and rewrite.

Writing the conclusion. Throughout your written review, you should communicate your new knowledge by combining the research question you asked with the literature you reviewed. End your writing with a conclusion that wraps up what you learned in the literature review process.
While the interaction between the research question and the relevant literature is foreshadowed throughout the review, it usually is written at the very end. The interaction itself is a learning process that gives researchers new insight into their area of research. The conclusion should reflect this.

3. 3.3 Sources of Literature

3.1 3.3.1 Primary Sources

Primary sources are original materials on which other research is based. They are from the time period involved and have not been filtered through interpretation or evaluation. They are usually the first formal appearance of results in physical, print or electronic format. They present original thinking, report a discovery, or share new information. Examples include:

1. Literary creation: novels, short stories, poems, etc.
2. Artifacts (e.g. coins, plant specimens, fossils, furniture, tools, clothing, all from the time under study);
3. Audio recordings (e.g. radio programs)
4. Diaries;
5. Internet communications on email, listservs;
6. Interviews (e.g., oral histories, telephone, e-mail);
7. Journal articles published in peer-reviewed publications;
8. Letters;
9. Newspaper articles written at the time;
10. Original Documents (i.e. birth certificate, will, marriage license, trial transcript);
11. Patents;
12. Photographs
13. Proceedings of Meetings, conferences and symposia;
14. Records of organizations, government agencies (e.g. annual report, treaty, constitution, government document);
15. Speeches;
16. Survey Research (e.g., market surveys, public opinion polls);
17. Video recordings (e.g. television programs);
18. Works of art, architecture, literature, and music (e.g., paintings, sculptures, musical scores, buildings, novels, poems).

3.2 3.3.2 Secondary Sources

Secondary sources are less easily defined than primary sources. Generally, they are accounts written after the fact with the benefit of hindsight. They are interpretations and evaluations of primary sources. Secondary sources are not evidence, but rather commentary on and discussion of evidence. However, what some define as a secondary source, others define as a tertiary source. Context is everything. Examples include:

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*www.lib.umd.edu/ues/guides/primary-sources (3.3 Chapter)*
3. Extensive literature survey

1. Bibliographies (also considered tertiary);
2. Biographical works;
3. Commentaries, criticisms;
4. Dictionaries, Encyclopedias (also considered tertiary);
5. Histories;
6. Literary criticism such as Journal articles;
7. Magazine and newspaper articles;
8. Monographs, other than fiction and autobiography;
9. Textbooks (also considered tertiary);
10. Web site (also considered primary).

3.3. 3.3.3 Tertiary sources

Tertiary sources consist of information which is a distillation and collection of primary and secondary sources.

1. Almanacs;
2. Bibliographies (also considered secondary);
3. Chronologies;
4. Dictionaries and Encyclopedias (also considered secondary);
5. Directories;
6. Fact books;
7. Guidebooks;
8. Indexes, abstracts, bibliographies used to locate primary and secondary sources;
9. Manuals;
10. Textbooks (also be secondary).

4. References and further reading

5. Questions for Chapter 3

1. Why do a literature review?
2. What is a literature review?
3. A literature is a ‘review’ of ‘the literature’ on a topic. What does that mean?
4. What is the process of the literature review?
4. fejezet - 4. A framework of the levels and aspects of the research methodology

Table 2 provides a detailed framework of the research methodology.

4.1. táblázat - Table 2. A framework of the levels and aspects of the research methodology

<table>
<thead>
<tr>
<th>Research Strategy</th>
<th>Research Design</th>
<th>Research methods and Techniques</th>
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<tbody>
<tr>
<td>Qualitative or quantitative (both Phase 1: survey and Phase, 2: content analysis)</td>
<td>Control over variables</td>
<td>Sampling design</td>
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<tr>
<td></td>
<td>• Experimental</td>
<td>• Unit of analysis</td>
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<td>• Ex post facto</td>
<td>• Population</td>
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<td>Sampling techniques</td>
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<td></td>
<td>• Probability (simple random, systematic, stratified, cluster sequential or multiphase)</td>
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<tr>
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<td>• Nonprobability (convenience, purposive, snowball)</td>
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<tr>
<td>Exploratory or formal research</td>
<td>Time dimension</td>
<td>Data collection</td>
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<td></td>
<td>• Cross-sectional</td>
<td>Data collection techniques</td>
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<td>• Longitudinal</td>
<td>• Quantitative data collection (e.g. experimental, survey, content analysis)</td>
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<td></td>
<td>• Qualitative data (e.g. field observation, historical research, content analysis)</td>
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<tr>
<td>Descriptive or causal research</td>
<td>Research environment</td>
<td>Data analysis</td>
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<td></td>
<td>• Field</td>
<td>Data analysis techniques</td>
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<td></td>
<td>• Laboratory</td>
<td>• Quantitative data collection (descriptive statistics, inferential statistics)</td>
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<td></td>
<td>• Simulation</td>
<td>• Qualitative data analysis (e.g. grounded theory, discourse analysis, conversation analysis)</td>
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<td>Perceptions of participants</td>
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<td>• Actual routine</td>
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1. **References and further reading**


5. fejezet - 5. Developing the hypothesis

1. 5.1 What is the Scientific Hypothesis?

A scientific hypothesis is the initial building block in the scientific method. Many describe it as an “educated guess,” based on prior knowledge and observation, as to the cause of a particular phenomenon. It is a suggested solution for an unexplained occurrence that does not fit into current accepted scientific theory. A hypothesis is the inkling of an idea that can become a theory, which is the next step in the scientific method.

The basic idea of a hypothesis is that there is no pre-determined outcome. For a hypothesis to be termed a scientific hypothesis, it has to be something that can be supported or refuted through carefully crafted experimentation or observation.

A key function in this step in the scientific method is deriving predictions from the hypotheses about the results of future experiments, then performing those experiments to see whether they support the predictions.

The primary trait of a hypothesis is that something can be tested and that those tests can be replicated. A hypothesis, which is often in the form of an if/then statement, is often examined by multiple scientists to ensure the integrity and veracity of the experiment. This process can take years, and in many cases hypotheses do not become theories as it is difficult to gather sufficient supporting evidence.

2. 5.2 Key of Hypothesis

These are as follows:

1. Explanatory or Descriptive Hypothesis: A hypothesis may be about the cause of a phenomenon or about the law of which it is an instance. A hypothesis about cause is explanatory whereas a hypothesis about law is descriptive.

2. Tentative Hypothesis: when a phenomenon cannot be fully understood because of technical difficulties the make tentative hypothesis about it and see how far this is successful in explaining.

3. Representative Fictitious Hypothesis: Some hypothesis consists of assumptions as to the certain phenomenon, these assumptions can never be proved by direct means. Their only merit is their suitability to express the phenomenon.

A representative fictitious hypothesis which proves to be correct becomes a theory or law.

3. 5.3 Steps in testing the hypothesis

1. Observation: Observation is a precondition of formulation of a hypothesis. Unless e perceive a difficulty or problem and do not feel the inner goading for solving it, we do not reflect. Therefore, observation is the first stage of hypothesis making.

2. Reflection: Having felt a difficulty and need for a solution we consider the problem by perceiving the relevant facts. Now we anticipate a relation which is based upon experience, namely, whenever there is high tide there is full moon and never otherwise as far as our experience goes. Having established a relation between two facts, we now formulate an answer for the why of this relation. This answer is hypothesis.

3. Deduction: The third and the last step in this process is testing of hypothesis, various deductions possible from it and their mutual compatibilities and correspondence with already known facts.

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1 www.livescience.com/21490-what-is-a-scientific-hypothesis-definition-of-hypothesis.html (5.1 Chapter)
2 www.uncp.edu/home/acurtis/Courses/ResourcesForCourses/LitReview.html (5.2 Chapter)
3 www.uncp.edu/home/acurtis/Courses/ResourcesForCourses/LitReview.html (5.3 Chapter)
4. Verification: Actually, verification is post hypothesis formulation and therefore is not a step in its formulation, but in as much as our interest in making hypothesis is not purely academic or theoretical, we wish to solve our difficulty and this difficulty can be solved, if we actually test our hypothesis.

4. 5.4 The good hypothesis

Hypothesis or workable hypothesis must have the following characteristics:

1. Specific in Nature: A hypothesis must not be vague or too general. It should be very specific. It means that the hypothesis should be quite narrow and up to the point.

2. Simplicity: A hypothesis must be simple, clear and understandable.

3. Conceptual Clarity: The hypothesis must lay down the concept quite clearly and the problems and the definitions that are used in the hypothesis should be properly and universally accepted terms.

4. Brevity: The hypothesis should be brief and be stated in scientific terms.

5. Related to Theory: Hypothesis must be corollary or in continuation with the theory already verified. If it is, it will help the development and growth of science.

6. Related to Technique or method: Hypothesis must be related to the available techniques or scientific method. Then only it will be capable of being tested or verified.

7. Capable of Empirical Test or Experiments: The workable hypothesis should be based on the existing experience and capable of the empirical test. It should not be a mere moral judgment.

A hypothesis may be directly or indirectly confirmable. It is confirmed directly if some observation or experiment can test it. The hypothesis that coffee taken at night makes a man sleepless can be tested by giving coffee at night to a number of people a number of times and observing its effect on them. Where we cannot confirm a hypothesis directly, we consider consequences derivable from it or we may examine the validity of its opposite consequences.

5. 5.5 Four steps to hypothesis testing

The goal of hypothesis testing is to determine the likelihood that a population parameter, such as the mean, is likely to be true:

1. State the hypotheses.

2. Set the criteria for a decision.

3. Compute the test statistic.

4. Make a decision.

5.1. 5.5.1 State the hypotheses

State the hypotheses. We begin by stating the value of a population mean in a null hypothesis, which we presume is true. For the children watching TV example, we state the null hypothesis that children in the Hungary watch an average of 3 hours of TV per week. This is a starting point so that we can decide whether this is likely to be true, similar to the presumption of innocence in a courtroom. When a defendant is on trial, the jury starts by assuming that the defendant is innocent. The basis of the decision is to determine whether this assumption is true. Likewise, in hypothesis testing, we start by assuming that the hypothesis or claim we are testing is true. This is stated in the null hypothesis. The basis of the decision is to determine whether this assumption is likely to be true.

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4 www.uncp.edu/home/acurtis/Courses/ResourcesForCourses/LitReview.html (5.4 Chapter)
5 www.sagepub.com/upm-data/40007_Chapter8.pdf
6 www.sagepub.com/upm-data/40007_Chapter8.pdf (5.5.1 Chapter)
The null hypothesis (H(0)), stated as the null, is a statement about a population parameter, such as the population mean, that is assumed to be true. The null hypothesis is a starting point. We will test whether the value stated in the null hypothesis is likely to be true.

Keep in mind that the only reason we are testing the null hypothesis is because we think it is wrong. We state what we think is wrong about the null hypothesis in an alternative hypothesis. For the children watching TV example, we may have reason to believe that children watch more than (> or less than (<) 3 hours of TV per week. When we are uncertain of the direction, we can state that the value in the null hypothesis is not equal to (≠) 3 hours.

An alternative hypothesis (H1) is a statement that directly contradicts a null hypothesis by stating that the actual value of a population parameter is less than, greater than, or not equal to the value stated in the null hypothesis. The alternative hypothesis states what we think is wrong about the null hypothesis, which is needed for Step 2.

### 5.2. 5.5.2 Set the criteria for decision

Set the criteria for a decision. The likelihood or level of significance is typically set at 5% in behavioral research studies. When the probability of obtaining a sample mean is less than 5% if the null hypothesis were true, then we conclude that the sample we selected is too unlikely and so we reject the null hypothesis.

The alternative hypothesis establishes where to place the level of significance. Remember that we know that the sample mean will equal the population mean on average if the null hypothesis is true. All other possible values of the sample mean are normally distributed (central limit theorem). The empirical rule tells us that at least 95% of all sample means fall within about 2 standard deviations (SD) of the population mean, meaning that there is less than a 5% probability of obtaining a sample mean that is beyond 2 SD from the population mean.

### 5.3. 5.5.3 State the hypotheses

Compute the test statistic. To make a decision, we need to evaluate how likely this sample outcome is, if the population mean stated by the null hypothesis is true. We use a test statistic to determine this likelihood. Specifically, a test statistic tells us how far, or how many standard deviations, a sample mean is from the population mean. The larger the value of the test statistic, the further the distance, or number of standard deviations, a sample mean is from the population mean stated in the null hypothesis. The value of the test statistic is used to make a decision in Step 4.

### 5.4. 5.5.4 Make a decision

We use the value of the test statistic to make a decision about the null hypothesis. The decision is based on the probability of obtaining a sample mean, given that the value stated in the null hypothesis is true. If the probability of obtaining a sample mean is less than 5% when the null hypothesis is true, then the decision is to reject the null hypothesis. If the probability of obtaining a sample mean is greater than 5% when the null hypothesis is true, then the decision is to retain the null hypothesis. In sum, there are two decisions a researcher can make:

1. Reject the null hypothesis. The sample mean is associated with a low probability of occurrence when the null hypothesis is true.
2. Retain the null hypothesis. The sample mean is associated with a high probability of occurrence when the null hypothesis is true.

The probability of obtaining a sample mean, given that the value stated in the null hypothesis is true, is stated by the p value. The p value is a probability: It varies between 0 and 1 and can never be negative. In Step 2, we stated the criterion or probability of obtaining a sample mean at which point we will decide to reject the value stated in the null hypothesis, which is typically set at 5% in behavioral research. To make a decision, we compare the p value to the criterion we set in Step 2.

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1. www.sagepub.com/upm-data/40007_Chapter8.pdf (5.5.2 Chapter)
2. www.sagepub.com/upm-data/40007_Chapter8.pdf (5.5.3 Chapter)
3. www.sagepub.com/upm-data/40007_Chapter8.pdf (5.5.4 Chapter)
5. Developing the hypothesis

When the p value is less than 5% (p < 0.05), we reject the null hypothesis. We will refer to p 0< 0.05 as the criterion for deciding to reject the null hypothesis, although note that when p = 0.05, the decision is also to reject the null hypothesis. When the p value is greater than 5% (p > 0.05), we retain the null hypothesis. The decision to reject or retain the null hypothesis is called significance. When the p value is less than 0.05, we reach significance; the decision is to reject the null hypothesis. When the p value is greater than 0.05, we fail to reach significance; the decision is to retain the null hypothesis.

6. References and further reading


6. The Review of Literature for Research: www.uncp.edu/home/acurtis/Courses/ResourcesForCourses/LitReview.html

7. What is the Scientific Hypothesis? Definition of Hypothesis:

www.livescience.com/21490-what-is-a-scientific-hypothesis-definition-of-hypothesis.html

7. Questions for Chapter 5

1. Define the term Hypothesis and explain its importance.

2. Explain the difficulties encountered in Formulation of a Hypothesis. How can these difficulties be removed.

3. Explain the steps in Testing a Hypothesis.

4. What are the Conditions of a Good hypothesis?

5. The decision in hypothesis testing is to retain or reject which hypothesis: the null or alternative hypothesis?

6. The criterion or level of significance in behavioral research is typically set at what probability value?

7. If the null hypothesis is rejected, then did we reach significance?

8. Defines the concept null hypothesis, alternative hypothesis, level of significance, test statistic, p value, and statistical significance.
6. Preparing the Research Design

Once the research problem has been identified, the researcher proceeds to prepare a research design. According to Russell Ackoff, “research design is the process of making decisions before a situation arises in which the decision has to be carried out”. It is the conceptual framework within which the research would be carried out. It is a key aspect as it binds the research project together. Its aim is to provide for the collection of relevant information with minimal expenditure of effort, time, and money.

But, whether this can be achieved depends upon a large extent on the research purpose, classified into four categories: (i) Exploratory; (ii) Description; (iii) Diagnosis; and (iv) Experimentation. For an exploratory research study, a flexible research design is more appropriate as it provides ample scope for researching various aspects of a problem. For a research paper, which requires an accurate description, the research design should be formulated in such a way that, it is unbiased and vouches for the reliability of the collected data and analyzed.

There are various kinds of research designs, such as, experimental (independent variable is manipulated) and non-experimental (independent variable is not manipulated) hypothesis-testing. Experimental designs can be further grouped into informal and formal. Informal experimental design normally uses a less sophisticated form of analysis. It includes: before and after without control design; after only with control design; before and after with control design. Formal experimental design offers relatively more control and uses precise statistical procedures for analysis. It includes: completely randomized design; randomized block design; Latin square design; and factorial designs.

While preparing a research design, the following factors are taken into consideration:

1. Objectives of the research study;
2. Means of obtaining the information;
3. Tools for data collection;
4. Data analysis (qualitative and quantitative);
5. Time available for each stage of the research; and
6. Cost involved for the research.

A well-planned research design serves as a blueprint for the researcher even before he actually starts working on his research. This helps him to decide his course of action during various stages of the research, thus saving his time and resources.

1. 6.1 Research Design defined

Research design can be defined in many ways. Some of the well known definitions are summarized as follows:

1. It is a conceptual framework under whose umbrella research will be conducted.
2. It is a design for collection of measurement and analysis of data
3. It is a decision matrix which looks into the aspects of 5WH (What, Where, Which, Where & How) as they pertain to a research enquiry.

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1 blog.reseapro.com/2012/06/04/preparing-the-research-design/
2 blog.reseapro.com/2012/06/04/preparing-the-research-design/
3 blog.reseapro.com/2012/06/04/preparing-the-research-design/
4 blog.reseapro.com/2012/06/04/preparing-the-research-design/
5 blog.reseapro.com/2012/06/04/preparing-the-research-design/
4. It can also be defined a mesh of boundary conditions for collection and interpretation of data which in turn leads to efficient conduct of research procedure.

The research design encompasses factors such as researcher control of variables, time dimensions, research environment and participant perceptions (Cooper and Schindler, 2001).

1.1. 6.1.1 Variables

A variable is something that can change, such as ‘gender’ and are typically the focus of a study. It may change from group to group, person to person, or even within one person over time. There are six common variable types.

1.1.1. 6.1.1.1 Dependent variables

Dependent variables show the effect of manipulating or introducing the independent variables. The variation in the dependent variable depends on the variation in the independent variable. In an experimental design, the independent variable is the variable that is manipulated by the experimenter to determine its relationship to an observed phenomenon, called the dependent variable. More generally, the independent variable is the ‘cause’, while dependent variable is the ‘effect’ of the independent variable.

1.1.2. 6.1.1.2 Independent variables

An independent variable is a factor that can be varied or manipulated in an experiment (e.g. time, temperature, concentration, etc). It is usually what will affect the dependent variable. There are two types of independent variables, which are often treated differently in statistical analyses: (1) quantitative variables that differ in amounts or scale and can be ordered (e.g. weight, temperature, time). (2) qualitative variables which differ in “types” and can not be ordered (e.g. gender, species, method). By convention when graphing data, the independent variable is plotted along the horizontal X-axis with the dependent variable on the vertical Y-axis.

1.1.3. 6.1.1.3 Intervening variables

Intervening variables refer to abstract processes that are not directly observable but that ulink the independent and dependent variables. An intervening variable is a hypothetical internal state that is used to explain relationships between observed variables, such as independent and dependent variables, in empirical research.

1.1.4. 6.1.1.4 Moderator variables

Moderator variables affect the relationship between the independent and dependent variables by modifying the effect of the intervening variable(s). A moderator variable is the independent qualitative or quantitative variable that affects the relationship of the dependent and independent variables. In correlation, a moderator is a third variable that affects the correlation of two variables.

1.1.5. 6.1.1.5 Control variables

Variables that have been controlled in this way are called control variables. A control variable is a variable that is held constant in a research analysis. The use of control variables is generally done to answer four basic kinds of questions:

1. Is an observed relationship between two variables just a statistical accident?
2. If one variable has a causal effect on another, is this effect a direct one or is it indirect with other variable intervening?
3. If several variables all have causal effects on the dependent variable, how does the strength of those effects vary?

1 linguistics.byu.edu/faculty/henrichsenl/ResearchMethods/RM_2_14.html
3 www.everythingbio.com/glos/definition.php?word=independent+variable
4 en.wikipedia.org/wiki/Intervening_variable
5 www.statisticssolutions.com/academic-solutions/resources/directory-of-statistical-analyses/moderator-variable/
6 sociology.about.com/od/C_INDEX/g/Control-Variable.htm
6. Preparing the research design

4. Does a particular relationship between two variables look the same under various conditions?

1.1.6. 6.1.1.6 Extraneous variables

Extraneous variables are those factors in the research environment which may have an effect on the dependent variable(s) but which are not controlled. Extraneous variables are dangerous. They may damage a study’s validity, making it impossible to know whether the effects were caused by the independent and moderator variables or some extraneous factor. If they cannot be controlled, extraneous variables must at least be taken into consideration when interpreting results.

1.2. 6.1.2 Time dimensions

Within the time dimension of the design, two possibilities exist: Cross-sectional studies and longitudinal studies. Sometimes, data are collected at one point in time, in what are called cross-sectional studies. These are often the simplest and easiest but make it difficult to understand processes occurring over time.

Longitudinal studies collect data at more than one point in time, making it easier to study change. Trend studies are a series of cross-sectional studies over time, asking the same question of different samples drawn from the same population.

1.3. 6.1.3 Research environment

Research can be conducted either under actual environmental, laboratory or simulated conditions.

2. 6.2 Elements of Research Design

The important elements of a research design are as under:

1. A specification of the sources and kind of information needed for conducting research
2. A strategic roadmap that will be deployed for collecting and analyzing data
3. A definition of both time lines and cost estimates since most research studies operate under these constraints.

In brief, a research design must contain:

1. A clear statement of the research problem
2. Procedures and techniques for information gathering from the sample of research population.
3. Mathematical algorithms to process and analyze the data.

Research design is not related to any particular method of collecting data or any particular type of data. Any research design can, in principle, use any type of data collection method and can use either quantitative or qualitative data. Research design refers to the structure of an enquiry: it is a logical matter rather than a logistical one.

It has been argued that the central role of research design is to minimize the chance of drawing incorrect causal inferences from data. Design is a logical task undertaken to ensure that the evidence collected enables us to answer questions or to test theories as unambiguously as possible. When designing research it is essential that we identify the type of evidence required to answer the research question in a convincing way. This means that we must not simply collect evidence that is consistent with a particular theory or explanation. Research needs to be structured in such a way that the evidence also bears on alternative rival explanations and enables us to identify which of the competing explanations is most compelling empirically. It also means that we must not

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11 linguistics.byu.edu/faculty/henrichsenl/ResearchMethods/RM_2_14.html
12 www.ebabbie.net/resource/practice/04/time.html
15 dspace.stir.ac.uk/bitstream/1893/71/4/Chapter%204.pdf
simply look for evidence that supports our favourite theory: we should also look for evidence that has the potential to disprove our preferred explanations\textsuperscript{18}.

### 3. 6.3 Types of Research Design

#### 3.1. 6.3.1 Action Research Design

The essentials of action research design follow a characteristic cycle whereby initially an exploratory stance is adopted, where an understanding of a problem is developed and plans are made for some form of interventional strategy. Then the intervention is carried out (the action in Action Research) during which time, pertinent observations are collected in various forms. The new interventional strategies are carried out, and the cyclic process repeats, continuing until a sufficient understanding of (or implement able solution for) the problem is achieved. The protocol is iterative or cyclical in nature and is intended to foster deeper understanding of a given situation, starting with conceptualizing and particularizing the problem and moving through several interventions and evaluations\textsuperscript{19}.

#### 3.2. 6.3.2 Case Study Design

A case study is an in-depth study of a particular research problem rather than a sweeping statistical survey. It is often used to narrow down a very broad field of research into one or a few easily researchable examples. The case study research design is also useful for testing whether a specific theory and model actually applies to phenomena in the real world. It is a useful design when not much is known about a phenomenon\textsuperscript{20}.

#### 3.3. 6.3.3 Causal Design

Causality studies may be thought of as understanding a phenomenon in terms of conditional statements in the form, 'If X, then Y'. This type of research is used to measure what impact a specific change will have on existing norms and assumptions. Most social scientists seek causal explanations that reflect tests of hypotheses. Causal effect (nomothetic perspective) occurs when variation in one phenomenon, an independent variable, leads to or results, on average, in variation in another phenomenon, the dependent variable\textsuperscript{21}.

#### 3.4. 6.3.4 Cohort Design

Often used in the medical sciences, but also found in the applied social sciences, a cohort study generally refers to a study conducted over a period of time involving members of a population which the subject or representative member comes from, and who are united by some commonality or similarity. Using a quantitative framework, a cohort study makes note of statistical occurrence within a specialized subgroup, united by same or similar characteristics that are relevant to the research problem being investigated, rather than studying statistical occurrence within the general population. Using a qualitative framework, cohort studies generally gather data using methods of observation. Cohorts can be either 'open' or 'closed'\textsuperscript{22}.

#### 3.5. 6.3.5 Cross-Sectional Design\textsuperscript{23}

Cross-sectional research is a research method often used in developmental psychology, but also utilized in many other areas including social science and education. This type of study utilizes different groups of people who differ in the variable of interest, but share other characteristics such as socioeconomic status, educational background, and ethnicity.

Cross-sectional studies are observational in nature and are known as descriptive research, not causal or relational. Researchers record the information that is present in a population, but they do not manipulate variables. This type of research can be used to describe characteristics that exist in a population, but not to determine cause-and-effect relationships between different variables. These methods are often used to make

\textsuperscript{19} www.docstoc.com/docs/146100254/Types-of-Research-Design  
\textsuperscript{20} explorablc.com/case-study-research-design  
\textsuperscript{21} www.docstoc.com/docs/146100254/Types-of-Research-Design  
\textsuperscript{22} explorablc.com/case-control-study  
\textsuperscript{23} psychology.about.com/od/cindex/g/cross-sectional.htm (6.3.5 Chapter)
inferences about possible relationships or to gather preliminary data to support further research and experimentation.

3.6. 6.3.6 Descriptive Design

Descriptive research is also called Statistical Research. The main goal of this type of research is to describe the data and characteristics about what is being studied. The idea behind this type of research is to study frequencies, averages, and other statistical calculations. Although this research is highly accurate, it does not gather the causes behind a situation. Descriptive research is mainly done when a researcher wants to gain a better understanding of a topic for example, a frozen ready meals company learns that there is a growing demand for fresh ready meals but doesn’t know much about the area of fresh food and so has to carry out research in order to gain a better understanding. It is quantitative and uses surveys and panels and also the use of probability sampling.

Descriptive research is the exploration of the existing certain phenomena. The details of the facts wont be known. The existing phenomenas facts are not known to the persons.

3.7. 6.3.7 Experimental Design

A blueprint of the procedure that enables the researcher to maintain control over all factors that may affect the result of an experiment. In doing this, the researcher attempts to determine or predict what may occur. Experimental Research is often used where there is time priority in a causal relationship (cause precedes effect), there is consistency in a causal relationship (a cause will always lead to the same effect), and the magnitude of the correlation is great. The classic experimental design specifies an experimental group and a control group. The independent variable is administered to the experimental group and not to the control group, and both groups are measured on the same dependent variable. Subsequent experimental designs have used more groups and more measurements over longer periods. True experiments must have control, randomization, and manipulation.

3.8. 6.3.8 Exploratory Design

Exploratory research is a form of research conducted for a problem that has not been clearly defined. Exploratory research helps determine the best research design, data collection method and selection of subjects. It should draw definitive conclusions only with extreme caution. Given its fundamental nature, exploratory research often concludes that a perceived problem does not actually exist.

An exploratory design is conducted about a research problem when there are few or no earlier studies to refer to. The focus is on gaining insights and familiarity for later investigation or undertaken when problems are in a preliminary stage of investigation.

3.9. 6.3.9 Historical Design

Historical research relies on records, diaries, oral histories, photographs, and other artifacts to describe, analyze, and explain past events, philosophies, etc. The artifacts and records used are driven by the particular study and its research question(s). Historical research relies significantly on inductive, logical reasoning.

The purpose of a historical research design is to collect, verify, and synthesize evidence from the past to establish facts that defend or refute your hypothesis. It uses secondary sources and a variety of primary documentary evidence, such as, logs, diaries, official records, reports, archives, and non-textual information (maps, pictures, audio and visual recordings). The limitation is that the sources must be both authentic and valid.

3.10. 6.3.10 Longitudinal Design

24 wiki.answers.com/Q/What_is_descriptive_research (6.3.6 Chapter)
25 www.docstoc.com/docs/146100254/Types-of-Research-Design
26 en.wikipedia.org/wiki/Exploratory_research
27 www.docstoc.com/docs/146100254/Types-of-Research-Design
28 www.charlesdennishale.com/books/eets_ap9_Qualitative_Research_Designs.pdf
29 www.docstoc.com/docs/146100254/Types-of-Research-Design
A longitudinal study follows the same sample over time and makes repeated observations. With longitudinal surveys, for example, the same group of people is interviewed at regular intervals, enabling researchers to track changes over time and to relate them to variables that might explain why the changes occur. Longitudinal research designs describe patterns of change and help establish the direction and magnitude of causal relationships. Measurements are taken on each variable over two or more distinct time periods. This allows the researcher to measure change in variables over time. It is a type of observational study and is sometimes referred to as a panel study.¹⁰

### 3.11. 6.3.11 Observational Design

This type of research design draws a conclusion by comparing subjects against a control group, in cases where the researcher has no control over the experiment. There are two general types of observational designs. In direct observations, people know that you are watching them. Unobtrusive measures involve any method for studying behavior where individuals do not know they are being observed. An observational study allows a useful insight into a phenomenon and avoids the ethical and practical difficulties of setting up a large and cumbersome research project.¹¹

### 3.12. 6.3.12 Philosophical Design

Philosophy of design is the study of assumptions, foundations, and implications of design. The field is defined by an interest in a set of problems, or an interest in central or foundational concerns in design. In addition to these central problems for design as a whole, many philosophers of design consider these problems as they apply to particular disciplines (e.g. philosophy of art). Although most practitioners are philosophers, several prominent designers and artists have contributed to the field. Although most practitioners are philosophers, several prominent designers and artists have contributed to the field.¹² Understood more as an broad approach to examining a research problem than a methodological design, philosophical analysis and argumentation is intended to challenge deeply embedded, often intractable, assumptions underpinning an area of study. This approach uses the tools of argumentation derived from philosophical traditions, concepts, models, and theories to critically explore and challenge, for example, the relevance of logic and evidence in academic debates, to analyze arguments about fundamental issues, or to discuss the root of existing discourse about a research problem.¹³

### 3.13. 6.3.13 Sequential Design

Sequential research is that which is carried out in a deliberate, staged approach (i.e. serially) where one stage will be completed, followed by another, then another, and so on, with the aim that each stage will build upon the previous one until enough data is gathered over an interval of time to test your hypothesis. The sample size is not predetermined. After each sample is analyzed, the researcher can accept the null hypothesis, accept the alternative hypothesis, or select another pool of subjects and conduct the study once again. This means the researcher can obtain a limitless number of subjects before finally making a decision whether to accept the null or alternative hypothesis. Using a quantitative framework, a sequential study generally utilizes sampling techniques to gather data and applying statistical methods to analyze the data. Using a qualitative framework, sequential studies generally utilize samples of individuals or groups of individuals (cohorts) and use qualitative methods, such as interviews or observations, to gather information from each sample.¹⁴

### 4. References and further reading

3. Control Variable: sociology.about.com/od/C_Index/g/Control-Variable.htm

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*explorable.com/case-control-study*  
*explorable.com/observational-study*  
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6. Case-study Research Design: explorable.com/case-study-research-design

7. Case-control Study: explorable.com/case-control-study

8. Cross-Sectional: psychology.about.com/od/index/g/cross-sectional.htm


10. Exploratory Research: en.wikipedia.org/wiki/Exploratory_research


12. Observational Study: explorable.com/observational-study


14. Preparing the Research Design: blog.reseapro.com/2012/06/04/preparing-the-research-design/


16. Research Design: explorable.com/research-designs

17. Research design and methodology: https://dspace.stir.ac.uk/bitstream/1893/71/4/Chapter%204.pdf


20. The Practice of Social Research: www.ebabbage.net/resource/practice/04/time.html

21. Types of the Research Designs: libguides.usc.edu/content.php?pid=83009&sid=818072


24. What is descriptive research?: wiki.answers.com/Q/What_is_descriptive_research

25. What is research design? www.nyu.edu/classes/bkg/methods/005847ch1.pdf

5. Questions for Chapter 6

1. What is the research design?

2. What kind of types the research design?

3. What is the definition of independent variable and dependent variable?

4. Let the descriptor characterize it Action Research Design; Case study Design; Sequential Design; Philosophical Design; Observational Design; Longitudinal Design; Historical Design; Exploratory Design; Experimental Design; Descriptive Design; Cross-Sectional Design?
7. fejezet - 7. Determining sample design

In statistics and survey methodology, sampling is concerned with the selection of a subset of individuals from within a statistical population to estimate characteristics of the whole population. Two advantages of sampling are that the cost is lower and data collection is faster. Each observation measures one or more properties of observable bodies distinguished as independent objects or individuals. In survey sampling, weights can be applied to the data to adjust for the sample design, particularly stratified sampling. Results from probability theory and statistical theory are employed to guide practice. In business and medical research, sampling is widely used for gathering information about a population.¹

1. 7.1 Basic Definitions

1.1. 7.1.1 Sampling

Sampling may be defined as the selection of some part of an aggregate or totality on the basis of which a judgment or inference about the aggregate or totality is made. Sampling is simply the process of learning about the population on the basis of a sample drawn from it. Thus in the sampling technique instead of every unit of the Universe only a part of the Universe is studied and the conclusions are drawn on that basis for the entire Universe².

1.2. 7.1.2 Population

A population is any entire collection of people, animals, plants or things from which we may collect data. It is the entire group we are interested in, which we wish to describe or draw conclusions about. In order to make any generalisations about a population, a sample, that is meant to be representative of the population, is often studied. For each population there are many possible samples. A sample statistic gives information about a corresponding population parameter. For example, the sample mean for a set of data would give information about the overall population mean. It is important that the investigator carefully and completely defines the population before collecting the sample, including a description of the members to be included.³

1.3. 7.1.3 Sample

A sample is that part of the universe which we select for the purpose of investigation. A sample exhibits the characteristics of the universe. The word sample literally means small universe⁴.

A sample is a group of units selected from a larger group (the population). A sample is generally selected for study because the population is too large to study in its entirety. The sample should be representative of the general population. This is often best achieved by random sampling. Also, before collecting the sample, it is important that the researcher carefully and completely defines the population, including a description of the members to be included⁵.

1.4. 7.1.4 Sampling design

A sampling design is a definite plan for obtaining a sample from the sampling frame. It refers to the technique or procedure of selecting some sampling units from which inferences about the population are drawn⁶.

2. 7.2 Statics and parameters

¹ en.wikipedia.org/wiki/Sampling_(statistics)
³ www.stats.gla.ac.uk/steps/glossary/basic_definitions.html#popn
⁵ www.stats.gla.ac.uk/steps/glossary/basic_definitions.html#popn
Parameters in statistics is an important component of any statistical analysis. In simple words, a parameter is any numerical quantity that characterizes a given population or some aspect of it. This means the parameter tells us something about the whole population.

2.1. 7.2.1 Sampling errors

In sample survey only a small part of the universe or population is studied, as such there is every possibility that its result would differ from each other. These differences constitute the errors due to sampling and are known as sampling errors.

Sampling process error occurs because researchers draw different subjects from the same population but still, the subjects have individual differences. Keep in mind that when you take a sample, it is only a subset of the entire population; therefore, there may be a difference between the sample and population. The most frequent cause of the said error is a biased sampling procedure. Every researcher must seek to establish a sample that is free from bias and is representative of the entire population. In this case, the researcher is able to minimize or eliminate sampling error.

2.1.1. 7.2.1.1 Standard deviations

Standard deviation is used to express the variability of the population.

3. 7.3 Precision

Precision is the range within which the population average for other parameter will lie in accordance with the reliability specified in the confidence level as percentage of the estimate ± or as a numerical quantity.

3.1. 7.3.1 Confidence level and significance level

In statistics, a confidence interval (CI) is a type of interval estimate of a population parameter and is used to indicate the reliability of an estimate. It is an observed interval (i.e. it is calculated from the observations), in principle different from sample to sample, that frequently includes the parameter of interest if the experiment is repeated. How frequently the observed interval contains the parameter is determined by the confidence level or confidence coefficient.

The significant level, on the other hand, indicates the likelihood of the observation falling outside the prescribed range. The significance level of a test is the probability that the test statistic will reject the null hypothesis when the (hypothesis) is true. Significance is a property of the distribution of a test statistic, not of any particular draw of the statistic.

3.2. 7.3.2 Sampling distribution

If we take certain number of samples and for each sample compute various statistical measures such as mean, standard deviation etc., then we can find out that each sample may give its own value for statistics under consideration.

4. 7.4 Difference between population and census

Sampling is a method of collecting information from a sample that is representative of entire population. There are both advantages and disadvantages of both the methods. Whereas data from census is reliable and accurate, there is a margin of error in data obtained from sampling. Census is very time consuming and expensive, whereas sampling is quick and inexpensive. However, if the next Census is far away, sampling is the most convenient method of obtaining data about the population (Table 3).
7. Determining sample design

7.1. táblázat - Table 3. Difference between population and census

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Values</th>
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<tbody>
<tr>
<td><strong>Definition</strong></td>
<td><strong>Population</strong></td>
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<tr>
<td></td>
<td>Collection of items in totality being considered for study</td>
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<td><strong>Characteristics</strong></td>
<td><strong>Parameter</strong></td>
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<td><strong>Symbols</strong></td>
<td>Population Size = $N$</td>
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<td>Population Mean = $\mu$</td>
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<td></td>
<td>Population S.D. = $\sigma$</td>
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</tbody>
</table>


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5. Confidence interval: en.wikipedia.org/wiki/Confidence_interval
8. Sampling Error: explorable.com/sampling-error

6. Questions for Chapter 7

1. What is sampling?
2. What are the different methods of sampling?
3. What are confidence intervals?
4. What is the difference between population and census?
8. Collecting the data

Data collection is any process of preparing and collecting data, for example, as part of a process improvement or similar project. The purpose of data collection is to obtain information to keep on record, to make decisions about important issues, or to pass information on to others. Data are primarily collected to provide information regarding a specific topic.

Data collection approaches for qualitative research usually involves:

1. Direct interaction with individuals on a one to one basis
2. Or direct interaction with individuals in a group setting

Qualitative research data collection methods are time consuming, therefore data is usually collected from a smaller sample than would be the case for quantitative approaches - therefore this makes qualitative research more expensive. The benefits of the qualitative approach is that the information is richer and has a deeper insight into the phenomenon under study. The main methods for collecting qualitative data are:

1. Individual interviews
2. Focus groups
3. Observations
4. Action Research

1. 8.1 Individual interviews

Interviews can be:

1. Unstructured
   a. Can be referred to as 'depth' or 'in depth' interviews.
   b. They have very little structure at all.
   c. The interviewer may just go with the aim of discussing a limited number of topics, sometimes as few as just one or two.
   d. The interviewer may frame the interview questions based on the interviewee and his/her previous response.
   e. This allows the discussion to cover areas in great detail.
   f. They involve the researcher wanting to know or find out more about a specific topic without there being a structure or a preconceived plan or expectation as to how they will deal with the topic.

2. Semi structured
   a. Semi structured interviews are sometimes also called focused interviews.
   b. A series of open ended questions based on the topic areas the researcher wants to cover.
   c. A series of broad questions to ask and may have some prompts to help the interviewee.
   d. 'The open ended nature of the question defines the topic under investigation but provides opportunities for both interviewer and interviewee to discuss some topics in more detail.'

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2 libweb.surrey.ac.uk/library/skills/Introduction%20to%20Research%20and%20Managing%20Information%20Leicester/page_54.htm
3 libweb.surrey.ac.uk/library/skills/Introduction%20to%20Research%20and%20Managing%20Information%20Leicester/page_55.htm (8.1 Chapter)
8. Collecting the data

e. Semi structured interviews allow the researcher to prompt or encourage the interviewee if they are looking for more information or find what they are saying interesting.

f. This method gives the researcher the freedom to probe the interviewee to elaborate or to follow a new line of inquiry introduced by what the interviewee is saying.

g. Work best when the interviewed has a number of areas he/she wants to be sure to be addressing.


a. The interviewer asks the respondent the same questions in the same way

b. A tightly structured schedule is used

c. The questions may be phrased in order that a limited range of responses may be given - i.e. „Do you rate our services as very good, good or poor”

d. A researcher needs to consider whether a questionnaire or structured interview is more appropriate

e. „If the interview schedule is too tightly structured this may not enable the phenomena under investigation to be explored in terms of either breadth or depth”.

Qualitative interviews should be fairly informal and participants feel they are taking part in a conversation or discussion rather than in a formal question and answer situation.

Good quality qualitative research involves:\

1. Thought

2. Preparation

3. The development of the interview schedule

4. Conducting and analysing the interview data with care and consideration

2. 8.2 Focus groups

The use of focus groups is sometimes used when it is better to obtain information from a group rather than individuals. Group interviews can be used when:\

1. Limited resources (time, manpower, finances).

2. The phenomena being researched requires a collective discussion in order to understand the circumstances, behaviour or opinions.

3. Greater insights may be developed of the group dynamic - or cause and consequence.

Characteristics of a focus group:\

1. Recommended size of the sample group is 6 - 10 people as smaller groups may limit the potential on the amount of information collected, and more may make it difficult for all participants to participate and interact and for the interviewer to be able to make sense of the information given.

2. Several focus groups should be used in order to get a more objective and macro view of the investigation. i.e. focussing on one group may give you idiosyncratic results. The use of several groups will add to the breadth and depth of information. A minimum of three focus groups is recommended for best practice approaches.

3. Members of the focus group should have something in common which is important to the investigation.

\[\text{libweb.surrey.ac.uk/library/skills/Introduction\%20to\%20Research\%20and\%20Managing\%20Information\%20Leicester/page_55.htm}\]

\[\text{libweb.surrey.ac.uk/library/skills/Introduction\%20to\%20Research\%20and\%20Managing\%20Information\%20Leicester/page_56.htm}\]

\[\text{libweb.surrey.ac.uk/library/skills/Introduction\%20to\%20Research\%20and\%20Managing\%20Information\%20Leicester/page_56.htm}\]
4. Groups can either be put together or existing groups – it is always useful to be mindful of the group dynamics of both situations.

The aim of the focus group is to make use of participants’ feelings, perceptions and opinions. This method requires the researcher to use a range of skills:

1. group skills
2. facilitating
3. moderating
4. listening/observing
5. analysis

3. 8.3 Observations

Observation involves may take place in natural settings and involve the researcher taking lengthy and descriptive notes of what is happening. It is argued that there are limits to the situations that can be observed in their 'natural' settings and that the presence of the research may lead to problems with validity.

Limitations with observation include:

1. Change in people's behaviour when they know they are being observed.
2. A 'snap shot' view of a whole situation.
3. Think Big Brother...
4. The researcher may miss something while they are watching and taking notes.
5. The researcher may make judgements of make value statements or misunderstand what has been observed.

Strengths of observation

1. Can offer a flavour for what is happening.
2. Can give an insight into the bigger picture.
3. Can demonstrate sub-groups.
4. Can be used to assist in the design of the rest of the research.

Sometimes, the researcher becomes or needs to become a participant observer, where they are taking part in the situation in order to be accepted and further understand the workings of the social phenomenon. Observation can sometimes obtain more reliable information about certain things - for example, how people actually behave (although it may not find out the reasons for why they behave in a particular way).

Techniques for collecting data through observation:

1. Written descriptions
   
a. The researcher makes written descriptions of the people, situations or environment
   
b. Limitations include
      
i. Researcher might miss out on an observation as they are taking notes
      
ii. The researcher may be focussed on a particular event or situation

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7 libweb.surrey.ac.uk/library/skills/Introduction%20to%20Research%20and%20Managing%20Information%20Leicester/page_57.htm (8.3 Chapter)
8. Collecting the data

iii. There is room for subjective interpretation of what is happening
c. Video recording
i. Allows the researcher to also record notes.
ii. Limitations may include people acting unnaturally towards the camera or others avoiding the camera.
iii. The camera may not always see everything.
d. Photographs and artefacts
i. Useful when there is a need to collect observable information or phenomena such as buildings, neighbourhoods, dress and appearance.
ii. Artefacts include objects of significance - memorabilia, instruments, tools etc.

4. 8.4 Action Research

Action research is a research initiated to solve an immediate problem or a reflective process of progressive problem solving led by individuals working with others in teams or as part of a "community of practice" to improve the way they address issues and solve problems. It sometimes called participatory action research.

Action Research doesn't just involve asking about it, it involves doing it. Action Research is a framework that is:

1. Collaborative.
2. There is a practical intervention made - i.e. you do something to make a change or intervention in a situation that you research (i.e. the work that we do in vcs...project monitoring and evaluation...use for bids).
3. The researcher will be actively involved in the planned intervention
4. Checklands FMA model
   a. F - framework of ideas
   b. M - methodology being applied
   c. A - area of concern

5. References and further reading

5. Action Research: en.wikipedia.org/wiki/Action_research
6. Introduction to Research, Observation:
   libweb.surrey.ac.uk/library/skills/Introduction%20to%20Research%20and%20Managing%20Information%20Leicester/page_57.htm

* en.wikipedia.org/wiki/Action_research
* libweb.surrey.ac.uk/library/skills/Introduction%20to%20Research%20and%20Managing%20Information%20Leicester/page_57.htm
6. Questions for Chapter 8

1. What is Data Collection?

2. Why do we need to collect data?

3. Why do we need a well-defined Data Collection process?

4. When should we develop a Data Collection plan?

5. What questions should the Data Collection plan answer?

6. What do we use to collect data?

7. What is observation method in research methodology?

8. Why use observation?
9. fejezet - 9. Execution of the project systemactic manner and in time

If the execution of the project is a very important steps in the research process. If the execution of the project proceeds on correct lines, the data to be collected would be adequate and dependable. The researcher should see that the project es executed in a systematic manner and in time. If the survey is to be conducted by means of structured questionnaires, data can be readily machine – processed (Rajendra, 2005).

1. 9.1 Preparing data

The researcher must prepare the data to be analyzed. Organizing the data correctly can save lot of time and prevent mistakes. Most researchers choose to use a database or statistical analysis program (Microsoft Excel, SPSS) that they can format to fit their needs in order to organize their data effectively. A good researcher enters all of the data in the same format and in the same database, as doing otherwise might lead to confusion and difficulty with the statistical analysis later on. Once the data has been entered, it is crucial that the researcher check the data for accuracy. This can be accomplished by spot-checking a random assortment of participant data groups, but this method is not as effective as re-entering the data a second time and searching for discrepancies. This method is particularly easy to do when using numerical data because the researcher can simply use the database program to sum the columns of the spreadsheet and then look for differences in the totals. Perhaps the best method of accuracy checking is to use a specialized computer program that cross-checks double-entered data for discrepancies (as this method is free from error), though these programs can be hard to come by and may require extra training to use correctly.

2. 9.2 Stages of preparing data

1. Checking data
2. Encoding
3. Input
4. Data cleaning
5. Correcting data for statistical purposes
6. Selecting data analysis strategy

2.1. 9.2.1 Checking data

When undertaking research it is imperative that your data is accurate. So you must carefully check your data. Thorough preparation and training is the first step in minimizing errors.

Checking questionnaires:

1. It means reviewing the questionnaires in order to make them more exact.
2. Must be examined whether the questionnaires include
   a. illegible;
   b. missing;
   c. inconsistent and;
   d. not unequivocal answers.

1 www.socialresearchmethods.net/kb/statprep.php
2 http://explorable.com/survey-research-design (9.2 Chapter)
3. If they do, it must be considered what should be done with these questionnaires.

### 2.2. 9.2.2 Encoding

Encoding means that a code generally a figure is assign to each possible answer of every question. The questionnaires are also coded (every questionnaire is given a figure) in this way data base is created which is already suitable computerized data analysis.

### 2.3. 9.2.3 Data cleaning

Data cleansing, data cleaning or data scrubbing is the process of detecting and correcting (or removing) corrupt or inaccurate records from a record set, table, or database. Used mainly in databases, the term refers to identifying incomplete, incorrect, inaccurate, irrelevant, etc. parts of the data and then replacing, modifying, or deleting this dirty data.

After cleansing, a data set will be consistent with other similar data sets in the system. The inconsistencies detected or removed may have been originally caused by user entry errors, by corruption in transmission or storage, or by different data dictionary definitions of similar entities in different stores.

Data cleansing differs from data validation in that validation almost invariably means data is rejected from the system at entry and is performed at entry time, rather than on batches of data.

The process of data cleaning:

1. Data auditing: The data is audited with the use of statistical and database methods to detect anomalies and contradictions: this eventually gives an indication of the characteristics of the anomalies and their locations.

2. Workflow specification: The detection and removal of anomalies is performed by a sequence of operations on the data known as the workflow. It is specified after the process of auditing the data and is crucial in achieving the end product of high-quality data. In order to achieve a proper workflow, the causes of the anomalies and errors in the data have to be closely considered.

3. Workflow execution: In this stage, the workflow is executed after its specification is complete and its correctness is verified.

4. Post-processing and controlling: After executing the cleansing workflow, the results are inspected to verify correctness. Data that could not be corrected during execution of the workflow is manually corrected, if possible. The result is a new cycle in the data-cleansing process where the data is audited again to allow the specification of an additional workflow to further cleanse the data by automatic processing.

### 2.4. 9.2.4 Correcting data for statistical purposes

1. Relative important: to each respondent a values of importance is assign, which shows the relative importance of the respondent in relation to the order respondent’s.

2. Redefining the variable: transforming the data or introducing new variable.

### 2.5. 9.2.5 Selecting data analysis strategy

Choosing statistical method in which the the purpose of research, the character of data, the researcher’s experience must be considered.

Statistics is the study of the collection, organization, analysis, interpretation, and presentation of data. It deals with all aspects of this, including the planning of data collection in terms of the design of surveys and experiments.

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3. 9.3 Statistical methods

Mathematical concepts, formulas, models, techniques used in statistical analysis of random data. In comparison, deterministic methods are used where the data is easily reproducible or where its behavior is determined entirely by its initial stage and inputs.

Methods of collecting, summarizing, analyzing, and interpreting variable numerical data. Statistical methods can be contrasted with deterministic methods, which are appropriate where observations are exactly reproducible or are assumed to be so. While statistical methods are widely used in the life sciences, in economics, and in agricultural science, they also have an important role in the physical sciences in the study of measurement errors, of random phenomena such as radioactivity or meteorological events, and in obtaining approximate results where deterministic solutions are hard to apply. Statistical analysis relates observed statistical data to theoretical models, such as probability distributions or models used in regression analysis. By estimating parameters in the proposed model and testing hypotheses about rival models, one can assess the value of the information collected and the extent to which the information can be applied to similar situations. Statistical prediction is the application of the model thought to be most appropriate, using the estimated values of the parameters.

3.1. 9.3.1 Univariate statistical methods

Univariate statistical analysis tests hypotheses involving only one variable (Figure 2).

3.2. 9.3.2 Multivariate statistical methods

Multivariate statistical analysis tests hypotheses and models involving multiple (three or more) variables or sets of variables (Figure 3).

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1. [www.businessdictionary.com/definition/statistical-methods.html](http://www.businessdictionary.com/definition/statistical-methods.html)
9. Execution of the project in a systematic manner and in time

4. References and further reading


5. Questions for Chapter 9

1. What is preparing data?

2. Demonstrate the process of preparing data.

3. What is encoding?

4. Demonstrate the process of data cleaning!
5. What does „correcting data for statistical purposes“ mean?

6. What kind of univariate statistical methods do you know?

7. What kind of multivariate statistical methods do you know?
10. fejezet - 10. Hypothesis testing

1. 10.1 What is hypothesis testing?

Hypothesis testing or significance testing is a method for testing a claim or hypothesis about a parameter in a population, using data measured in a sample. In this method, we test some hypothesis by determining the likelihood that a sample statistic could have been selected, if the hypothesis regarding the population parameter were true.

A statistical hypothesis is an assumption about a population parameter. This assumption may or may not be true. Hypothesis testing refers to the formal procedures used by statisticians to accept or reject statistical hypotheses.

1.1. 10.1.1 Statistical hypotheses

The best way to determine whether a statistical hypothesis is true would be to examine the entire population. Since that is often impractical, researchers typically examine a random sample from the population. If sample data are not consistent with the statistical hypothesis, the hypothesis is rejected.

There are two types of statistical hypotheses.

1. Null hypothesis. The null hypothesis, denoted by H₀, is usually the hypothesis that sample observations result purely from chance.

2. Alternative hypothesis. The alternative hypothesis, denoted by H₁ or Hₐ, is the hypothesis that sample observations are influenced by some non-random cause.

Some researchers say that a hypothesis test can have one of two outcomes: you accept the null hypothesis or you reject the null hypothesis. Many statisticians, however, take issue with the notion 'accepting the null hypothesis'. Instead, they say: you reject the null hypothesis or you fail to reject the null hypothesis. Why the distinction between 'acceptance' and 'failure to reject'? Acceptance implies that the null hypothesis is true. Failure to reject implies that the data are not sufficiently persuasive for us to prefer the alternative hypothesis over the null hypothesis.

2. 10.2 Hypothesis tests

Statisticians follow a formal process to determine whether to reject a null hypothesis, based on sample data. This process, called hypothesis testing, consists of four steps (Figure 4):

1. State the hypotheses. This involves stating the null and alternative hypotheses. The hypotheses are stated in such a way that they are mutually exclusive. That is, if one is true, the other must be false.

2. Formulate an analysis plan. The analysis plan describes how to use sample data to evaluate the null hypothesis. The evaluation often focuses around a single test statistic (set the criteria for a decision).

3. Analyze sample data. Find the value of the test statistic (mean score, proportion, t-score, z-score, etc.) described in the analysis plan.

4. Interpret results. Apply the decision rule described in the analysis plan. If the value of the test statistic is unlikely, based on the null hypothesis, reject the null hypothesis (make a decision).

10.1. ábra - Figure 4. Summary of hypothesis testing
3. 10.3 Decision Rules

The analysis plan includes decision rules for rejecting the null hypothesis. In practice, statisticians describe these decision rules in two ways – with reference to a P-value or with reference to a region of acceptance.

1. **P-value.** The strength of evidence in support of a null hypothesis is measured by the P-value. Suppose the test statistic is equal to $S$. The P-value is the probability of observing a test statistic as extreme as $S$, assuming the null hypothesis is true. If the P-value is less than the significance level, we reject the null hypothesis.

2. **Region of acceptance.** The region of acceptance is a range of values. If the test statistic falls within the region of acceptance, the null hypothesis is not rejected. The region of acceptance is defined so that the chance of making a Type I error is equal to the significance level.

3. The set of values outside the region of acceptance is called the region of rejection. If the test statistic falls within the region of rejection, the null hypothesis is rejected. In such cases, we say that the hypothesis has been rejected at the $\alpha$ level of significance.

These approaches are equivalent. Some statistics texts use the P-value approach; others use the region of acceptance approach. In subsequent lessons, this tutorial will present examples that illustrate each approach.

4. 10.4 One-Tailed and Two-Tailed Tests

Suppose we have a null hypothesis $H(0)$ and an alternative hypothesis $H(1)$. We consider the distribution given by the null hypothesis and perform a test to determine whether or not the null hypothesis should be rejected in favour of the alternative hypothesis.

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1. stattrek.com/hypothesis-test/hypothesis-testing.aspx (10.3 Chapter)
2. www.mathsrevision.net/alevel/pages.php?page=64
There are two different types of tests that can be performed. A one-tailed test looks for an increase or decrease in the parameter whereas a two-tailed test looks for any change in the parameter (which can be any change-increase or decrease). We can perform the test at any level (usually 1%, 5% or 10%). For example, performing the test at a 5% level means that there is a 5% chance of wrongly rejecting H(0). If we perform the test at the 5% level and decide to reject the null hypothesis, we say 'there is significant evidence at the 5% level to suggest the hypothesis is false'.

4.1. 10.4.1 What is a two-tailed test?

First let's start with the meaning of a two-tailed test. If you are using a significance level of 0.05, a two-tailed test allot half of your alpha to testing the statistical significance in one direction and half of your alpha to testing statistical significance in the other direction. This means that 0.025 is in each tail of the distribution of your test statistic. When using a two-tailed test, regardless of the direction of the relationship you hypothesize, you are testing for the possibility of the relationship in both directions. For example, we may wish to compare the mean of a sample to a given value x using a t-test. Our null hypothesis is that the mean is equal to x. A two-tailed test will test both if the mean is significantly greater than x and if the mean significantly less than x. The mean is considered significantly different from x if the test statistic is in the top 2.5% or bottom 2.5% of its probability distribution, resulting in a p-value less than 0.05 (Figure 5).

10.2. ábra - Figure 5. Two-Tailed Tests

Sources: www.ats.ucla.edu/stat/mult_pkg/faq/general/tail_tests.htm

4.2. 10.4.2 What is a one-tailed test?

If you are using a significance level of 0.05, a one-tailed test allot all of your alpha to testing the statistical significance in the one direction of interest (Figure 6). This means that 0.05 is in one tail of the distribution of your test statistic. When using a one-tailed test, you are testing for the possibility of the relationship in one direction and completely disregarding the possibility of a relationship in the other direction. Let's return to our example comparing the mean of a sample to a given value x using a t-test. Our null hypothesis is that the mean is equal to x. A one-tailed test will test either if the mean is significantly greater than x or if the mean is significantly less than x, but not both. Then, depending on the chosen tail, the mean is significantly greater than or less than x if the test statistic is in the top 5% of its probability distribution or bottom 5% of its probability distribution, resulting in a p-value less than 0.05. The one-tailed test provides more power to detect an effect in one direction by not testing the effect in the other direction. A discussion of when this is an appropriate option follows.

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8 www.mathsrevision.net/alevel/pages.php?page=64
9 www.ats.ucla.edu/stat/mult_pkg/faq/general/tail_tests.htm (10.4.1 Chapter)
9 www.ats.ucla.edu/stat/mult_pkg/faq/general/tail_tests.htm (10.4.2 Chapter)
5. 10.5 One-Tailed and Two-Tailed Tests

5.1. 10.5.1 Parametric statistics

Parametric statistics is a branch of statistics that assumes that the data has come from a type of probability distribution and makes inferences about the parameters of the distribution. Most well-known elementary statistical methods are parametric. Generally speaking, parametric methods make more assumptions than non-parametric methods. If those extra assumptions are correct, parametric methods can produce more accurate and precise estimates. They are said to have more statistical power. However, if assumptions are incorrect, parametric methods can be very misleading. For that reason they are often not considered robust. On the other hand, parametric formulae are often simpler to write down and faster to compute. In some, but definitely not all cases, their simplicity makes up for their non-robustness, especially if care is taken to examine diagnostic statistics.

5.1.1. 10.5.1.1 One sample hypothesis tests: Z-test

The one-independent sample z-test is a statistical procedure used to test hypotheses concerning the mean in a single population with a known variance.

A one-sample z-test is used to test whether a population parameter is significantly different from some hypothesized value. The one-sample z-test can be used when the population is normally distributed, and the population variance is known.

The value of the test statistic is compared to the critical values. When the value of a test statistic exceeds a critical value, we reject the null hypothesis; otherwise, we retain the null hypothesis:

1. The underlying distribution is normal or the Central Limit Theorem can be assumed to hold
2. The sample has been randomly selected

Sources: www.ats.ucla.edu/stat/mult_pkg/faq/general/tail_tests.htm

References:

15. en.wikipedia.org/wiki/Student's_t-test
3. The population standard deviation is known or the sample size is at least 25.

5.1.2. 10.5.1.2 One sample hypothesis tests t-test

A t-test is any statistical hypothesis test in which the test statistic follows a Student’s t distribution if the null hypothesis is supported. It can be used to determine if two sets of data are significantly different from each other, and is most commonly applied when the test statistic would follow a normal distribution if the value of a scaling term in the test statistic were known. When the scaling term is unknown and is replaced by an estimate based on the data, the test statistic (under certain conditions) follows a Student’s t distribution.

The one-sample z test is used to compare a mean from a single sample to an expected “norm.” The norm for the test comes from a hypothetical value or observations in prior studies, and does not come from the current data.

1. The underlying distribution is normal or the Central Limit Theorem can be assumed to hold.
2. The sample has been randomly selected.

The basic idea of the test is a comparison of the average of the sample (observed average) and the population (expected average), with an adjustment for the number of cases in the sample and the standard deviation of the average.

5.1.3. 10.5.1.3 Two sample hypothesis tests z-test

There are two samples from two populations (the samples can be different sizes). The two samples are independent. Both populations are normally distributed or both sample sizes are large enough that the means are normally distributed. (A rule of thumb is each sample size is n ≥ 30.) Both population standard deviations are known.

1. The underlying distribution is normal or the CLT can be assumed to hold
2. The samples have been randomly and independently selected from two populations
3. The population standard deviations are known or the sample size of each sample is at least 25.

5.1.4. 10.5.1.4 Two sample hypothesis tests t-test

We often want to know whether the means of two populations on some outcome differ. The two-sample t-test is a hypothesis test for answering questions about the mean where the data are collected from two random samples of independent observations, each from an underlying normal distribution.

The steps of conducting a two-sample t-test are quite similar to those of the one-sample test.

1. The underlying distribution is normal or the CLT can be assumed to hold.
2. The samples have been randomly and independently selected from two populations.
3. The variability of the measurements in the two populations is the same and can be measured by a common variance.

The results of statistical tests are frequently misunderstood. Therefore, I’m going to list some of the fallacies of hypothesis testing here. It will be helpful to refer back to this list as you grapple with the interpretation of hypothesis tests results:

1. Failure to reject the null hypothesis leads to its acceptance. (Failure to reject the null hypothesis implies insufficient evidence for its rejection.)

17 www.sjsu.edu/faculty/gerstman/StatPrimer/hyp-test.pdf
18 http://en.wikipedia.org/wiki/Z-test (10.5.3.1 Chapter)
19 ccnmtl.columbia.edu/projects/qmss/the_ttest/twosample_ttest.html
2. The p value is the probability that the null hypothesis is incorrect. (The p value is the probability of the current data or data that is more extreme assuming \( H(0) \) is true.)

3. \( \alpha = 0.05 \) is a standard with an objective basis. (\( \alpha = 0.05 \) is merely a convention that has taken on unwise mechanical use. There is no sharp distinction between “significant” and “insignificant” results, only increasingly strong evidence as the p value gets smaller. Surely god loves \( p = 0.06 \) nearly as much as \( p = 0.05 \))

4. Small p values indicate large effects. (p values tell you next to nothing about the size of an effect.)

5. Data show a theory to be true or false. (Data can at best serve to bolster or refute a theory or claim.)

6. Statistical significance implies importance. (Statistical significance says very little about the importance of a relation.)

6. 10.6 Non-parametrics statistic\(^{21}\)

In statistics, the term non-parametric statistics has at least two different meanings:

1. The first meaning of non-parametric covers techniques that do not rely on data belonging to any particular distribution. These include, among others:
   a. Distribution free methods, which do not rely on assumptions that the data are drawn from a given probability distribution. As such it is the opposite of parametric statistics. It includes non-parametric statistical models, inference and statistical tests.
   b. Non-parametric statistics (in the sense of a statistic over data, which is defined to be a function on a sample that has no dependency on a parameter), whose interpretation does not depend on the population fitting any parametrized distributions. Statistics based on the ranks of observations are one example of such statistics and these play a central role in many non-parametric approaches.

2. The second meaning of non-parametric covers techniques that do not assume that the structure of a model is fixed. Typically, the model grows in size to accommodate the complexity of the data. In these techniques, individual variables are typically assumed to belong to parametric distributions, and assumptions about the types of connections among variables are also made. These techniques include, among others:
   a. Non-parametric regression, which refers to modeling where the structure of the relationship between variables is treated non-parametrically, but where nevertheless there may be parametric assumptions about the distribution of model residuals.
   b. Non-parametric hierarchical Bayesian models, such as models based on the Dirichlet process, which allow the number of latent variables to grow as necessary to fit the data, but where individual variables still follow parametric distributions and even the process controlling the rate of growth of latent variables follows a parametric distribution.

6.1. 10.6.1 Kolmogorov-Smirnov test

In statistics, the Kolmogorov–Smirnov test (K–S test) is a nonparametric test for the equality of continuous, one-dimensional probability distributions that can be used to compare a sample with a reference probability distribution (one-sample K–S test), or to compare two samples (two-sample K–S test). The Kolmogorov–Smirnov statistic quantifies a distance between the empirical distribution function of the sample and the cumulative distribution function of the reference distribution, or between the empirical distribution functions of two samples. The null distribution of this statistic is calculated under the null hypothesis that the samples are drawn from the same distribution (in the two-sample case) or that the sample is drawn from the reference distribution (in the one-sample case). In each case, the distributions considered under the null hypothesis are continuous distributions but are otherwise unrestricted\(^{22}\).

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\(^{21}\) en.wikipedia.org/wiki/Non-parametric_statistics (10.6 Chapter)

\(^{22}\) www.princeton.edu/~achaney/tmve/wiki100k/docs/Kolmogorov-Smirnov_test.html
The two-sample KS test is one of the most useful and general nonparametric methods for comparing two samples, as it is sensitive to differences in both location and shape of the empirical cumulative distribution functions of the two samples. The Kolmogorov–Smirnov test can be modified to serve as a goodness of fit test. In the special case of testing for normality of the distribution, samples are standardized and compared with a standard normal distribution. This is equivalent to setting the mean and variance of the reference distribution equal to the sample estimates, and it is known that using these to define the specific reference distribution changes the null distribution of the test statistic: see below. Various studies have found that, even in this corrected form, the test is less powerful for testing normality than the Shapiro–Wilk test or Anderson–Darling test.

6.2. 10.6.2 Mann-Whitney U

In statistics, the Mann–Whitney U test (also called the Mann–Whitney–Wilcoxon (MWW), Wilcoxon rank-sum test or Wilcoxon–Mann–Whitney test) is a non-parametric statistical hypothesis test for assessing whether one of two samples of independent observations tends to have larger values than the other. It is one of the most well-known non-parametric significance tests.

Mann-Whitney U test holds the following assumptions:

1. The populations do not follow any specific parametrized distributions.
2. The populations of interest have the same shape.
3. The populations are independent of each other.

Use this when two different groups of participants perform both conditions of your study: i.e., it is appropriate for analysing the data from an independent-measures design with two conditions. Use it when the data do not meet the requirements for a parametric test (i.e. if the data are not normally distributed; if the variances for the two conditions are markedly different; or if the data are measurements on an ordinal scale). Otherwise, if the data meet the requirements for a parametric test, it is better to use an independent-measures t-test (also known as a 'two-sample' t-test). The logic behind the Mann-Whitney test is to rank the data for each condition, and then see how different the two rank totals are. If there is a systematic difference between the two conditions, then most of the high ranks will belong to one condition and most of the low ranks will belong to the other one. As a result, the rank totals will be quite different. On the other hand, if the two conditions are similar, then high and low ranks will be distributed fairly evenly between the two conditions and the rank totals will be fairly similar. The Mann-Whitney test statistic "U" reflects the difference between the two rank totals. The smaller it is (taking into account how many participants you have in each group) then the less likely it is to have occurred by chance. A table of critical values of U shows you how likely it is to obtain your particular value of U purely by chance. Note that the Mann-Whitney test is unusual in this respect: normally, the bigger the test statistic, the less likely it is to have occurred by chance.

6.3. 10.6.3 Wilcoxon signed-rank test

The Wilcoxon signed-rank test is a non-parametric statistical hypothesis test used when comparing two related samples, matched samples, or repeated measurements on a single sample to assess whether their population mean ranks differ (i.e. it is a paired difference test). It can be used as an alternative to the paired Student's t-test, t-test for matched pairs, or the t-test for dependent samples when the population cannot be assumed to be normally distributed. Assumption:

1. Data are paired and come from the same population.
2. Each pair is chosen randomly and independent.
3. The data are measured on an interval scale (ordinal is not sufficient because we take differences), but need not be normal.

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23 en.wikipedia.org/wiki/Kolmogorov-Smirnov_test#cite_note-0
24 en.wikipedia.org/wiki/Mann%E2%80%93Whitney_U
25 www.sussex.ac.uk/Users/grahamh/RM1web/MannWhitneyHandout%202011.pdf
26 en.wikipedia.org/wiki/Wilcoxon_signed-rank_test
6.4. 10.6.4 McNemar’s test

In statistics, McNemar's test is a normal approximation used on nominal data. It is applied to 2×2 contingency tables with a dichotomous trait, with matched pairs of subjects, to determine whether the row and column marginal frequencies are equal ("marginal homogeneity")\(^7\).

McNemar’s test is a non-parametric test that is used to compare two population proportions that are related or correlated to each other. This test is also used when we analyze a study where subjects are tested before and after time periods. It is applied by a 2×2 contingency table with the dichotomous variable. It is also known as the test for marginal homogeneity for K×K table\(^8\).

7. 10.7 Hypothesis Testing with SPSS

7.1. 10.7.1 Hypothesis Testing Using Cross Tabs and Chi-Square Test

Pearson's chi-squared test is used to assess two types of comparison: tests of goodness of fit and tests of independence.

1. A test of goodness of fit establishes whether or not an observed frequency distribution differs from a theoretical distribution.

2. A test of independence assesses whether paired observations on two variables, expressed in a contingency table, are independent of each other (e.g. polling responses from people of different nationalities to see if one's nationality affects the response).

The chi-squared test hypothesis

1. \( H(0) \) (Null hypothesis): there is no association between the two criteria.

2. \( H(1) \) (Alternative hypothesis): there is association between the two criteria.

Using cross tabulation the correlation of two nominal and ordinal or categorized metric variables are analysed. Crosstab analysis is the simultaneous testing of two frequency analyses in the case of two non-metrical variables.

Chi-square (pronounced 'ky', not like the trendy drink) is used to test for the significance of relationships between variables cross-classified in a bivariate table. The chi-square test results in a chi-square statistic that tells us the degree to which the conditional distributions (the distribution of the dependent variable across different values of the independent variable) differ from what we would expect under the assumption of 'statistical independence'.

In other words, as in other hypothesis tests, we are setting up a null hypothesis and trying to reject it. In this case, the null hypothesis says that there is no relationship between the variables in our bivariate table (i.e., that they are statistically independent) and that any difference between the conditional distributions that we see is actually just due to random sampling error. If we reject the null hypothesis, we will lend support to the research hypothesis that there is a real relationship between the variables in the population from which the sample is drawn\(^9\).

7.2. 10.7.2 Using SPSS to conduct a Chi-Square Test of Significance

To conduct a chi-square test, you need two variables that can reasonably be handled in a bivariate table (i.e., with a limited number of categories). Open the sample data (download: 'chi square'). In SPSS choose Analyze, Descriptive Statistics…, Crosstabs. This will open the dialog box in which you choose the two variables to be

\(^7\) en.wikipedia.org/wiki/McNemar%27s_test
\(^8\) www.statisticssolutions.com/academic-solutions/resources/directory-of-statistical-analyses/mcnemars-test/
\(^9\) staff.washington.edu/glynn/chispsps.pdf
\(^9\) https://portal.agr.unideb.hu/oktatok/drvinczeszilvia/oktatas/oktatott_targyak/statistika_kutatasmodszetan_index/index.html

51

Created by XMLmind XSL-FO Converter.
included in the bivariate table and chi-square test. Remember that the independent variable should occupy the columns and the dependent variable the rows of your table. Choose these by highlighting variables from your list and clicking the appropriate right-pointing arrows next to the 'Column(s)' and 'Row(s)' boxes (Figure 8).

10.4. ábra - Figure 8. Cross Tabulation in SPSS

Once you’ve selected your variables, request a chi-square statistic for the table(s) by clicking on the "Statistics" box and then marking the selection box next to 'Chi-square' in the upper left hand corner of the resulting dialog box (Figure 8a).

In case of nominal scale:
1. Phi and Cramer's V: Phi is a chi-square-based measure of association that involves dividing the chi-square statistic by the sample size and taking the square root of the result. Cramer's V is a measure of association based on chi-square.

2. Contingency coefficient: A measure of association based on chi-square. The value ranges between 0 and 1, with 0 indicating no association between the row and column variables and values close to 1 indicating a high degree of association between the variables. The maximum value possible depends on the number of rows and columns in a table.

3. Lambda: a measure of association that reflects the proportional reduction in error when values of the independent variable are used to predict values of the dependent variable. A value of 1 means that the independent variable perfectly predicts the dependent variable. A value of 0 means that the independent variable is no help in predicting the dependent variable.

In case of ordinal scale:

1. Kendall tau b: A nonparametric measure of correlation for ordinal or ranked variables that take ties into account. The sign of the coefficient indicates the direction of the relationship, and its absolute value indicates the strength, with larger absolute values indicating stronger relationships. Possible values range from -1 to 1, but a value of -1 or +1 can be obtained only from square tables.

2. Kendall tau c: A nonparametric measure of association for ordinal variables that ignores ties. The sign of the coefficient indicates the direction of the relationship, and its absolute value indicates the strength, with larger absolute values indicating stronger relationships. Possible values range from -1 to 1, but a value of -1 or +1 can be obtained only from square tables.

3. Gamma: A symmetric measure of association between two ordinal variables that ranges between -1 and 1. Values close to an absolute value of 1 indicate a strong relationship between the two variables. Values close to 0 indicate little or no relationship. For 2-way tables, zero-order gammas are displayed. For 3-way to n-way tables, conditional gammas are displayed.

4. Somers d: A measure of association between two ordinal variables that ranges from -1 to 1. Values close to an absolute value of 1 indicate a strong relationship between the two variables, and values close to 0 indicate little or no relationship between the variables. Somers' d is an asymmetric extension of gamma that differs only in the inclusion of the number of pairs not tied on the independent variable. A symmetric version of this statistic is also calculated.

Now click on ‘Cells…’ button to specify the contents in the cells of the crosstabs table. You may want to request column percentages so you can get an idea of the strength of the differences between the conditional distributions (remember that the chi-square test just tells us whether or not the relationship is present; a large chi-square does not indicate a stronger relationship because it is greatly affected by the size of the sample). You can do this by clicking on 'Cells' and choosing 'Column' under the 'Percentages' heading. While you are here, you can also ask SPSS to report the expected frequencies for each cell by clicking on 'Expected' under the 'Counts' heading. These will help you see exactly where the obtained value of the chi-square statistic comes from. Return to the main dialog box by hitting the 'Continue' button (Figure 9). After you've made all your selections, hit 'OK'.

10.5. ábra - Figure 9. Cross Tabulation in SPSS / Cells
Looking at Output from Crosstabs (Figure 10). The descriptive statistics tell you the total number of cases, and the number of cases within each cell. The second box below is called a 'crosstabulation' box.

10.6. ábra - Figure 10. Cross Tabulation in SPSS / Output
Part 2 is the significance and effect size. The Pearson Chi-Square indicates that there is a significant relationship between the two variables. The second box is the strength of that relationship. Use 'Phi' when you have two variables, each with two levels (2x2). Use 'Cramer’s V' for all other situations (Figure 11).

In the table Chi-Square Tests result, SPSS also tells us that “8 cells have expected count less than 5 and the minimum expected count is 1.40”. The sample size requirement for the chi-square test of independence is satisfied.

The probability of the chi-square test statistic (chi-square = 3.256) was $p = 0.353$, greater than the alpha level of significance of 0.05. The null hypothesis that differences in “What kind does the education consider his standard” are independent of differences in ‘sex’ is not rejected.

10.7. ábra - Figure 11. Cross Tabulation in SPSS / Output
The research hypothesis is not supported by this analysis. Thus, the answer for this question is False. We do not interpret cell differences unless the chi-square test statistic supports the research hypothesis.

Notice that SPSS produces the familiar bivariate table, including the expected cell frequencies and column percentages (if you requested them). The next box contains the chi-square score for the table (labeled Pearson chi-square), the table's degrees of freedom, and the p-value associated with the obtained chi-square score. Also note that SPSS reports how many of the cells in the table have an expected frequency below 5. Remember, this is an important diagnostic tool because chi-square becomes unreliable when your table has cells with expected frequencies below 5.

As always, you can reach a conclusion about your hypothesis by comparing the obtained Pearson chi-square to the critical value of chi-square, or by comparing the reported p-value to your chosen alpha level.

### 7.3. 10.7.3 Hypothesis Testing: One Sample t-test

A one sample t-test allows us to test whether a sample mean (of a normally distributed interval variable) significantly differs from a hypothesized value. Open the sample data (download: 'one sample t-test'). In the Statistics Viewer choose: Analyse / Compare Means / One Sample t-test… (this is shorthand for clicking on the Analyze menu item at the top of the window, and then clicking on Compare Means from the drop down menu, and One-Sample T Test from the pop up men. The One-Sample t Test dialog box will appear. Select the dependent variable(s) that you want to test by clicking on it in the left hand pane of the One-Sample t Test dialog box. Then click on the arrow button to move the variable into the Test Variable(s) pane. In this example, move the Travel variable (“To wath extent do you prefer calm and recreation during you travel?”) into the Test Variables box (Figure 12).

![Figure 12. Analyse / Compare Means / One-Sample t-test](https://portal.agr.unideb.hu/oktatok/drvinczeszilvia/oktatas/oktatott_targyak/statistika_kutatamodszertan_index/index.html)
10. Hypothesis testing

Click on the OK button to perform the one-sample t test. The output viewer will appear. There are two parts to the output (Figure 13). The first part gives descriptive statistics for the variables that you moved into the Test Variable(s) box on the One-Sample t Test dialog box. In this example, we get descriptive statistics for the Travel variable. This output tells us that we have 136 observations (N), the mean number of older siblings is 2.9 and the standard deviation of the number of older siblings is 1.222. The standard error of the mean (the standard deviation of the sampling distribution of means) is 0.105 (1.222 / square root of 136 = 0.105).

10.9. ábra - Figure 13. Analyse / Compare Means / One-Sample t-test / Output

**T-Test**

| To what extent do you prefer camping and recreation during your travel? |
|---|---|---|---|
| N | Mean | Std. Deviation | Std Error Mean |
| 136 | 2.99 | 1.222 | 0.105 |

The second part of the output gives the value of the statistical test. The second column of the output gives us the t-test value: (2.9 - 1) / (1.222 / square root of 136) = 27.706 (if you do the calculation, the values will not match exactly because of round-off error). The third column tells us that this t test has 135 degrees of freedom (136 - 1 = 135). The fourth column tells us the two-tailed significance (the 2-tailed p value.)
When t-Test can be Used? The examined variable is a variable measured on an interval- and ratio scale. The examined variable must be of normal distribution.

1. The higher the item number the more probable that the distribution is normal.

2. Since the t-test is robust, it can be used even if the sample is not of normal distribution.

There are further tests for examining normality e. g. Kolmogorov-Smirnov test.

**7.4. 10.7.4 Kolmogorov-Smirnov Test**

In statistics, the Kolmogorov-Smirnov test (K–S test) is a nonparametric test for the equality of continuous, one-dimensional probability distribution that can be used to compare a sample with a reference probability distribution (one-sample K–S test), or to compare two samples (two-sample K–S test). The Kolmogorov-Smirnov statistic quantifies a distance between the empirical distribution function of the sample and the cumulative distribution function of the reference distribution, or between the empirical distribution functions of two samples. The null distribution of this statistic is calculated under the null hypothesis that the samples are drawn from the same distribution (in the two-sample case) or that the sample is drawn from the reference distribution (in the one-sample case). In each case, the distributions considered under the null hypothesis are continuous distributions but are otherwise unrestricted.

Given a set of data, we would like to check if its distribution is normal. In this example, the null hypothesis is that the data is normally distributed and the alternative hypothesis is that the data is not normally distributed. The data to be tested in stored in the second column. Open the database 'Explore'. Select Analyze / Descriptive Statistics / Explore and a new window pops out. From the list on the left, select the variable 'Travel' to the 'Dependent List' (Figure 14).

10.10. ábra - Figure 14. Analyse / Descriptive Statistics / Explore

Click 'Plots' on the right. A new window pops out. Check 'None' for boxplot, uncheck everything for descriptive and make sure the box 'Normality plots with tests' and 'Histogram' is checked. The results now pop out in the 'Output' window (Figure 15). We can now interpret the result. The test statistics are shown in the third table. Here two tests for normality are run. For dataset small than 2000 elements, we use the Shapiro-Wilk test, otherwise, the Kolmogorov-Smirnov test is used. In our case, since we have only 20 elements, the Shapiro-
Wilk test is used. From A, the p-value is 0.000. We can’t reject the alternative hypothesis and conclude that the data not comes from a normal distribution (Figure 20).

10.11. ábra - Figure 15. Analyse / Descriptive Statistics / Explore /Output

An informal approach to testing normality is to compare a histogram of the sample data to a normal probability curve. The empirical distribution of the data (the histogram) should be bell-shaped and resemble the normal distribution (Figure 16). This might be difficult to see if the sample is small. In this case one might proceed by regressing the data against the quantiles of a normal distribution with the same mean and variance as the sample. Lack of fit to the regression line suggests a departure from normality. Lack of fit to the regression line suggests a departure from normality.33

10.12. ábra - Figure 16. Analyse / Descriptive Statistics / Explore /Output / Histogram

33 en.wikipedia.org/wiki/Normality_test
A graphical tool for assessing normality is the normal probability plot, a quantile-quantile plot (QQ plot) of the standardized data against the standard normal distribution. Here the correlation between the sample data and normal quantiles (a measure of the goodness of fit) measures how well the data is modeled by a normal distribution. For normal data the points plotted in the QQ plot should fall approximately on a straight line, indicating high positive correlation. These plots are easy to interpret and also have the benefit that outliers are easily identified.

### 7.5. 10.7.5 Paired-Sample t-Test

A paired sample t-test is used to determine whether there is a significant difference between the average values of the same measurement made under two different conditions. Both measurements are made on each unit in a sample, and the test is based on the paired differences between these two values.

The usual null hypothesis is that the difference in the mean values is zero. For example, the yield of two strains of barley is measured in successive years in twenty different plots of agricultural land (the units) to investigate whether one crop gives a significantly greater yield than the other, on average.

Beyond normal distribution, the precondition of applying the test is that the variance (dispersion square) of the variable should be the same in the two groups to be compared (condition of variance homogeneity – F-test).

If in the two samples there are data from different individuals and the two samples were selected independently of each other then the two samples are independent of each other (Independent-samples), while if the two data samples represent data selected from related data, then the two samples a related (Paired-samples).

In the hotel guest satisfaction survey we want to know whether there is a significant difference between foreign and domestic tourists independents on hotel services.

1. H(0): The opinions of the two guest groups about hotel services are the same.
2. H(1): The opinions of the two guest groups about hotel services are different.

F test: compares the variance of ones guest group with the other:

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10. Hypothesis testing

1. The two samples are homoscedastic (have the same variance) if the value of the F-test is high (e.g. higher than 95%).

2. The two samples are heteroscedastic (have different variance) if the value of the F-test is lower than 95%.

Open the sample data (download: ‘paired sample t-test’). The simplest way to carry out a paired t-test in SPSS is to compute the differences (using Transform, Compute) and then carrying out a one-sample t-test as follows: Analyze / Compare Means / Paired-Sample T Test. Select ‘Domestic’ and ‘Foreign’ together, then click the arrow button to enter them as the paired variables (Figure 17).

**10.13. ábra - Figure 17. Analyse / Compare Means / Paired-Sample t-Test**

Click the ‘Options…’ button and enter the appropriate confidence level (95%), if needed. Click ‘Continue’ to close the options and then click ‘OK’.

You will be presented with 3 tables in the output viewer under the title ‘T-Test’ but you only need to look at two tables - Paired Sample Statistics Table and the Paired Samples Test table.

You should use the output information in the following manner to answer the question (Figure 18).

The first table provides basic sample and variable statistics for the two variables, including the Mean, the sample size, the Standard Deviation, and the Standard Error of the Mean. You can use the data here to describe the characteristics of the first and second samples in your results. The ‘domestic’ counselors report a mean of 4.67. Those appear to be quite different scores, but the question of interest is whether those scores are different due to chance. The paired-samples t test allows us to determine that.

The second table, a correlation table, is discussed in the chapter on correlation, so it will not be discussed here.

The third table titled ‘Paired Samples Test’ is the table where the results of the dependent t-test are presented.

A lot of information is presented here and it is important to remember that this information refers to differences between the two samples. As such, the columns of the table labelled ‘Mean’, ‘Std. Deviation’, ‘Std. Error

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https://portal.agr.unideb.hu/oktatok/drvinczeszilvia/oktatas/oktatott_targyak/statisztika_kutatasmodoszteran_index/index.html
Mean’, 95% CI refer to the mean difference between the two jumps and the standard deviation, standard error and 95% CI of this difference, respectively. The last 3 columns express the results of the dependent t-test, namely the t-value, the degrees of freedom and the significance level.

10.14. ábra - Figure 18. Analyse / Compare Means / Paired-Sample t-Test / Output

Because p < 0,05: the null hypothesis is rejected, i.e. the opinions of the two groups are not the same.

7.5.1. 10.7.5.1 Independent t-Test

The independent t-test is an inferential test designed to tell us whether we should accept or reject our null hypothesis. You have learned that any two samples from the same population are unlikely to have the same mean. If you carry out an experiment or collect data from two samples because you expect to see a difference between them, you have a problem because there will almost always be some difference due to sampling! It is vital to know whether the difference between the means of your two samples is due to the effect of sampling or to a true difference between the populations they were sampled from.

When applicable the independent t-test?

1. Independent variable consists of two independent groups.
2. Dependent variable is either interval or ratio (see our guide on Types of Variable).
3. Dependent variable is approximately normally distributed (see Testing for Normality article)
4. Similar variances between the two groups (homogeneity of variances) (tested for in this t-test procedure).

To determine whether your samples are normally distributed read our Testing for Normality article. What if your samples are not normally distributed? Well, if your data set is large then small deviations are generally tolerable. However, if your samples are small or your data set is largely non-normal then you need to consider a non-parametric test instead, such as the Mann-Whitney U Test.

The assumption of equal variances is tested in SPSS by Levene’s Test for Equality of Variances. The result of this test is presented in the output when running an independent t-test and is discussed later in this guide.

8. References and further reading


* www.gla.ac.uk/sums/users/narjis/stroke/indept1.html (10.7.5.1 Chapter)


8. Datat Preparation: www.socialresearchmethods.net/kb/statprep.php


18. McNemar Test: en.wikipedia.org/wiki/McNemar%27s_test


22. One and twi tailed tests: www.mathsrevision.net/alevel/pages.php?page=64


25. The Mann-Whitney Test: www.sussex.ac.uk/Users/grahamh/RM1web/MannWhitneyHandout%202011.pdf


27. The t-Test: ccnmtl.columbia.edu/projects/qmss/the_ttest/twosample_ttest.html

28. What is Hypothesis Testing?: stattrek.com/hypothesis-test/hypothesis-testing.aspx

29. Wilcoxon Signed Rank Test: en.wikipedia.org/wiki/Wilcoxon_signed-rank_test
9. Questions for Chapter 10

1. What are the differences between one-tailed and two-tailed tests?
2. What is a two-tailed test?
3. The decision in hypothesis testing is to retain or reject which hypothesis: the null or alternative hypothesis?
4. A test statistic is associated with a p value less than .05 or 5%. What is the decision for this hypothesis test?
5. If the null hypothesis is rejected, then did we reach significance?
6. What kind of simple hypothesis testing do you know?
7. What is the one-sample t-test?
8. Demonstrate the chi-test.
9. What is phi, Cramer’s V, contingency coefficient, Lambda, Goodman and Kruskal tau?
10. What kind of values can Kendall tau b and c, gamma, Somers d take?
11. What does this test do?
12. What variables do you need for a dependent t-test?
13. What is meant by "related groups"?
14. Does the dependent t-test test for "changes" or "differences" between related groups?
15. How do you detect differences between experimental conditions using the dependent t-test?
16. How do you detect differences between experimental conditions using the dependent t-test?
17. On what other ways could you use the dependent t-test?
18. What are the assumptions of the dependent t-test?
19. What hypothesis is being tested?
20. What is the advantage of a dependent t-test over an independent t-test?
21. Can a dependent t-test be used to compare different subjects?
22. How do you report the result of a dependent t-test?
23. Should you report confidence levels?
11. fejezet - 11. Analysis of data

Statistics is a science that involves the extraction of information from numerical data obtained during an experiment or from a sample. It involves the design of the experiment or sampling procedure, the collection and analysis of the data, and making inferences (statements) about the population based upon information in a sample.

Statistics is the study of how to collect, organize, analyze, and interpret numerical information from data. Descriptive statistics involves methods of organizing, picturing and summarizing information from data. Inferential statistics involves methods of using information from a sample to draw conclusions about the population.

1. 11.1 Individuals and Variables

Individuals are the people or objects included in the study (individuals are the objects described by a set of data). A variable is the characteristic of the individual to be measured or observed (variables are characteristics of individuals). A quantitative variable has a value or numerical measurement for which operations such as addition or averaging make sense. A qualitative variable describes and individual by placing the individual into a category or group such as male or female.

1.1. 11.1.1 Qualitative vs. quantitative variables

Variables can be classified as qualitative (aka, categorical) or quantitative (aka, numeric).

1. Qualitative. Qualitative variables take on values that are names or labels. The color of a ball (e.g., red, green, blue) or the breed of a dog (e.g., collie, shepherd, terrier) would be examples of qualitative or categorical variables.

2. Quantitative. Quantitative variables are numeric. They represent a measurable quantity. For example, when we speak of the population of a city, we are talking about the number of people in the city – a measurable attribute of the city. Therefore, population would be a quantitative variable.

1.2. 11.1.2 Discrete vs. Continous Variables

Quantitative variables can be further classified as discrete or continuous. If a variable can take on any value between its minimum value and its maximum value, it is called a continuous variable; otherwise, it is called a discrete variable.

1. Discrete data can only take particular values. There may potentially be an infinite number of those values, but each is distinct and there's no grey area in between. Discrete data can be numeric - like numbers of apples - but it can also be categorical - like red or blue, or male or female, or good or bad.

2. Continuous variables can take a value based on a measurement at any point along a continuum. The value given to an observation for a continuous variable can include values as small as the instrument of measurement allows. Examples of continuous variables include height, time, age, and temperature.

1.3. 11.1.3 Univariate vs. Bivariate Data

Statistical data are often classified according to the number of variables being studied.

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1 www.math.utah.edu/~firas/1070/Chapter_01.pdf
2 faculty.palomar.edu/mmumford/120/notes/Chap1.pdf
3 faculty.palomar.edu/mmumford/120/notes/Chap1.pdf
4 stattrek.com/descriptive-statistics/variables.aspx (11.1.1 Chapter)
5 stattrek.com/descriptive-statistics/variables.aspx
6 stats.stackexchange.com/questions/206/what-is-the-difference-between-discrete-data-and-continuous-data
7 www.abs.gov.au/websitedbs/a3121120.nsf/home/statistical+language++what+are+variables
8 stattrek.com/descriptive-statistics/variables.aspx (11.1.3 Chapter)
1. Univariate data: when we conduct a study that looks at only one variable, we say that we are working with univariate data. Suppose, for example, that we conducted a survey to estimate the average weight of high school students. Since we are only working with one variable (weight), we would be working with univariate data.

2. Bivariate data: when we conduct a study that examines the relationship between two variables, we are working with bivariate data. Suppose we conducted a study to see if there were a relationship between the height and weight of high school students. Since we are working with two variables (height and weight), we would be working with bivariate data.

2. 11.2 Levels of Measurement

The 'levels of measurement', or scales of measure are expressions that typically refer to the theory of scale types developed by the psychologist Stanley Smith Stevens. Stevens proposed his theory in a 1946 Science article titled 'On the theory of scales of measurement'.

In that article, Stevens claimed that all measurement in science was conducted using four different types of scales that he called ‘nominal’, ‘ordinal’, ‘interval’ and ‘ratio’, unifying both qualitative and quantitative.

1. Nominal Level (in name only): Qualities with no ranking/ordering; no numerical or quantitative value.

2. Ordinal Level: Can be arranged in some numerical order, but the differences between the data values are meaningless.

3. Interval Level: Data values can be ranked and the differences between data values are meaningful. However, there is no intrinsic zero, or starting point, and the ratio of data values are meaningless.

4. Ratio Level: Similar to interval, except there is an inherent zero, or starting point, and the ratios of data values have meaning.

2.1. 11.2.1 Nominal Level of Measurement

The nominal level of measurement is the lowest of the four ways to characterize data. Nominal means ‘in name only’ and that should help to remember what this level is all about. Nominal data deals with names, categories, or labels.

Data at the nominal level is qualitative. Colors of eyes, yes or no responses to a survey, and favorite breakfast cereal all deal with the nominal level of measurement.

Data at this level can’t be ordered in a meaningful way, and it makes no sense to calculate things such as means and standard deviations.

Nominal variables take on values that are not able to be organised in a logical sequence. For example, in a data set males could be coded as 0, females as 1; marital status of an individual could be coded as Y if married, N if single.

2.2. 11.2.2 Ordinal Level of Measurement

The next level is called the ordinal level of measurement. Data at this level can be ordered, but no differences between the data can be taken that are meaningful.

Ordinal variables take on values that can be logically ordered or ranked. The categories associated with ordinal variables can be ranked higher or lower than another, but do not necessarily establish a numeric difference between the each category. Examples of ordinal categorical variables include academic grades (i.e. A, B, C), clothing size (i.e. small, medium, large, extra large) and attitudes (i.e. strongly agree, agree, disagree, strongly disagree).

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* en.wikipedia.org/wiki/Level_of_measurement
* faculty.palomar.edu/mnumford/120/notes/Chap1.pdf
* statistics.about.com/od/HelpandTutorials/a/Levels-Of-Measurement.htm (11.2.1 Chapter)
* www.abs.gov.au/websitedbs/a3121120.nsf/home/statistical+language+-+what+are+variables
2.3. 11.2.3 Interval Level of Measurement

The interval level of measurement deals with data that can be ordered, and in which differences between the data does make sense. Data at this level does not have a starting point. The Fahrenheit and Celsius scales of temperatures are both examples of data at the interval level of measurement. You can talk about 30 degrees being 60 degrees less than 90 degrees, so differences do make sense. However 0 degrees (in both scales) cold as it may be does not represent the total absence of temperature. Data at the interval level can be used in calculations. However, data at this level does lack one type of comparison. Even though \( 3 \times 30 = 90 \), it is not correct to say that 90 degrees Celsius is three times as hot as 30 degrees Celsius.\(^{13}\)

For example, the time interval between the starts of years 1981 and 1982 is the same as that between 1983 and 1984, namely 365 days. The zero point, year 1 AD, is arbitrary; time did not begin then. Other examples of interval scales include the heights of tides, and the measurement of longitude.

2.4. 11.2.4 Ratio Level of Measurement\(^{14}\)

The fourth and highest level of measurement is the ratio level. Data at the ratio level possess all of the features of the interval level, in addition to a zero value. Due to the presence of a zero, it now makes sense to compare the ratios of measurements.

At the ratio level of measurement, not only can sums and differences be calculated, but also ratios. One measurement can be divided by any nonzero measurement, and a meaningful number will result.

3. 11.3 Simple Basic Statistics

When performing statistical analysis on a set of data, the mean, median, mode, and standard deviation are all helpful values to calculate. The mean, median and mode are all estimates of where the “middle” of a set of data is. These values are useful when creating groups or bins to organize larger sets of data. The standard deviation is the average distance between the actual data and the mean.\(^{15}\)

1. Frequency Table
2. Measures of central tendency: Mean; Mode; Median
3. Measures of dispersion or variation: Range; Mean Deviation; Variance; Standard Deviation; Coefficient of Variation
4. Measures of association: Covariance; Correlation Coefficient, Coefficient of Determination

3.1. 11.3.1 Frequency Table

A frequency table is a way of summarising a set of data. It is a record of how often each value (or set of values) of the variable in question occurs. It may be enhanced by the addition of percentages that fall into each category. A frequency table is used to summarise categorical, nominal, and ordinal data. It may also be used to summarise continuous data once the data set has been divided up into sensible groups. When we have more than one categorical variable in our data set, a frequency table is sometimes called a contingency table because the figures found in the rows are contingent upon (dependent upon) those found in the columns.

For example: Suppose that in thirty shots at a target, a marksman makes the following scores:

5; 2; 2; 3; 4;
4; 3; 2; 0; 3;
0; 3; 2; 1; 5;

\(^{13}\) statistics.about.com/od/HelpandTutorials/a/Levels-Of-Measurement.htm
\(^{14}\) statistics.about.com/od/HelpandTutorials/a/Levels-Of-Measurement.htm (11.2.4 Chapter)
\(^{15}\) controls.engin.umich.edu/wiki/index.php/Basic_statistics:_mean,_median,_average,_standard_deviation,_z-scores,_and_p-value#Basic_Statistics
The frequencies of the different scores can be summarised as (Table 4):

### 11.1. táblázat - Table 4. The frequencies of the different scores

<table>
<thead>
<tr>
<th>Score</th>
<th>Frequency</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>23</td>
</tr>
</tbody>
</table>

#### 3.1.1. 11.3.1.1 Frequency Analasis with SPSS

Frequencies options include a table showing counts and percentages, statistics including percentile values, central tendency, dispersion and distribution, and charts including bar charts and histograms. The steps for using the frequencies procedure is to click the 'Analyze' menu, 'Descriptive Statistics' then from the submenu choose 'Frequencies' and select your variables for analysis. You can then choose statistics options, choose chart options, choose format options, and have SPSS calculate your request.

Download the database 'Frequency Analasis'\. Choosing Frequencies Procedure: From the 'Analyze' menu, highlight 'Descriptive Statistics', then move to the sub menu and click on 'Frequencies' (Figure 19).

### 11.1. ábra - Figure 19. Frequency Analasis with SPSS

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A dialog box will appear providing a scrollable list of the variables on the left, a 'Variable(s)' choice box, and buttons for 'Statistics', 'Charts' and 'Format' options (Figure 20). Selecting Variables for Analysis: First select your variable from the main frequencies dialog box by clicking the variable name once. (Use the scroll bar if you do not see the variable you want.) Click the arrow to the left of the 'Variable(s):' box (Figure 20), to move 'shots' into the box. All variables selected for this box will be included in any procedures you decide to run. We could click OK to obtain a frequency and percentage distribution of the variables, but in most cases we would continue and choose one or more statistics.

Choosing Statistics for Variables: Click the 'Statistics' button, bottom of Figure 20, and a dialog box of statistical choices will appear.

This variable is a nominal (category) variable so click only the 'Mode' box within the central tendency choices. After clicking the 'Mode' box click the 'Continue' button, top right, and we return to the main 'Frequencies' dialog box (Figure 20.).

We could now click 'OK' and SPSS would calculate and present the frequency and percent distribution (click 'OK' if you want) but, in the more typical manner, we will continue and include choices for charts and check out the 'Options' possibilities. If you clicked 'OK', just press the 'Analysis' menu then choose 'Descriptive Statistics' and then 'Frequencies' from the sub menu and you will be back to this point with your variable and statistics chosen.

11.2. ábra - Figure 20. Frequency Analysis with SPSS, Frequencies, Frequencies Statistics
Choosing Charts for Variables: On the main frequencies window, click the 'Charts' button, and a dialog box of chart choices, Figure 21, will appear. Click 'Bar Chart', as I have done, since this is a categorical variable, then click 'Continue' to return to the main Frequencies window box. If this were a continuous variable I would choose 'Histograms' and the 'With Normal Curve' option would be available.

I would choose the 'With Normal Curve' option to have a normal curve drawn over my distribution so that I could visually see how close the distribution is to normal.

'Frequencies' is automatically chosen for chart values but if desired you could change that to 'Percentages'. Now click 'OK' on the main frequencies dialog box and SPSS will calculate and present a frequency and percent distribution with our chosen format, statistics, and chart.

Looking at Output from Frequencies: We will now take a brief look at our output from the SPSS frequencies procedure. (Processing time for SPSS to perform the analysis in the steps above will depend on the size of the data set, the amount of work you are asking SPSS to do and the CPU speed of your computer). The 'SPSS Output Navigator', left side, and the output, right side, will appear when SPSS has completed its computations.
11. Analysis of data

Either scroll down to the chart in the right window, or click the "Bar Chart" icon in the outline pane to the left of the output as we did in Figure 22.

11.3. ábra - Figure 22. Frequency Analysis with SPSS, Frequencies, Output

We now see the chart, Figure 23. The graphic is a bar chart with the categories at the bottom, the X axis, and the frequency scale at the left, the Y axis (Figure 23.) Step-column chart that displays a summary of the variations in (frequency distribution of) quantities (called Classes) that fall within certain lower and upper limits in a set of data. Classes are measured on the horizontal (‘X’) axis, and the number of times they occur (or the percentages of their occurrences) are measured on the vertical (‘Y’) axis. To construct a histogram, rectangles or blocks are drawn on the x-axis (without any spaces between them) whose areas are proportional to the classes they represent. Histograms (and histographs) are used commonly where the subject item is discrete (such as the number of students in a school) instead of being continuous (such as the variations in their heights). A histogram is usually preferred over a histogram where the number of classes is less than eight. Also called frequency diagram\(^\text{17}\).

11.4. ábra - Figure 23. Frequency Analysis with SPSS, Frequency diagram

\(^{17}\) www.businessdictionary.com/definition/histogram.html
3.2. 11.3.2 Nominal Level of Measurement

3.2.1. 11.3.2.1 Measures of Center

Plotting data in a frequency distribution shows the general shape of the distribution and gives a general sense of how the numbers are bunched. Several statistics can be used to represent the ‘center’ of the distribution. These statistics are commonly referred to as measures of central tendency.

1. Mode: The mode of a distribution is simply defined as the most frequent or common score in the distribution. The mode is the point or value of X that corresponds to the highest point on the distribution. If the highest frequency is shared by more than one value, the distribution is said to be multimodal. It is not uncommon to see distributions that are bimodal reflecting peaks in scoring at two different points in the distribution.

2. Median: the median is the score that divides the distribution into halves; half of the scores are above the median and half are below it when the data are arranged in numerical order. The median is also referred to as the score at the 50th percentile in the distribution. The median location of N numbers can be found by the formula (N + 1) / 2. When N is an odd number, the formula yields an integer that represents the value in a numerically ordered distribution corresponding to the median location.

3. Mean: the mean is the most common measure of central tendency and the one that can be mathematically manipulated. It is defined as the average of a distribution is equal to the ∑ X / N. Simply, the mean is computed by summing all the scores in the distribution ( ∑ X ) and dividing that sum by the total number of scores (N). The mean is the balance point in a distribution such that if you subtract each value in the distribution from the mean and sum all of these deviation scores, the result will be zero.

3.2.2. 11.3.2.2 Measures of Spread

Although the average value in a distribution is informative about how scores are centered in the distribution, the mean, median, and mode lack context for interpreting those statistics. Measures of variability provide information about the degree to which individual scores are clustered about or deviate from the average value in a distribution.
1. Range: the simplest measure of variability to compute and understand is the range. The range is the difference between the highest and lowest score in a distribution. Although it is easy to compute, it is not often used as the sole measure of variability due to its instability. Because it is based solely on the most extreme scores in the distribution and does not fully reflect the pattern of variation within a distribution, the range is a very limited measure of variability.

2. Interquartile Range (IQR): provides a measure of the spread of the middle 50% of the scores. The IQR is defined as the 75th percentile - the 25th percentile. The interquartile range plays an important role in the graphical method known as the boxplot. The advantage of using the IQR is that it is easy to compute and extreme scores in the distribution have much less impact but its strength is also a weakness in that it suffers as a measure of variability because it discards too much data. Researchers want to study variability while eliminating scores that are likely to be accidents. The boxplot allows for this for this distinction and is an important tool for exploring data.

3. Variance: the variance is a measure based on the deviations of individual scores from the mean. As noted in the definition of the mean, however, simply summing the deviations will result in a value of 0. To get around this problem the variance is based on squared deviations of scores about the mean. When the deviations are squared, the rank order and relative distance of scores in the distribution is preserved while negative values are eliminated. Then to control for the number of subjects in the distribution, the sum of the squared deviations, $\sum (X - \bar{X})^2$, is divided by N (population) or by N - 1 (sample). The result is the average of the sum of the squared deviations and it is called the variance.

4. Standard deviation: the standard deviation (σ or $\sigma$) is defined as the positive square root of the variance. The variance is a measure in squared units and has little meaning with respect to the data. Thus, the standard deviation is a measure of variability expressed in the same units as the data. The standard deviation is very much like a mean or an "average" of these deviations. In a normal (symmetric and mound-shaped) distribution, about two-thirds of the scores fall between +1 and -1 standard deviations from the mean and the standard deviation is approximately 1/4 of the range in small samples (N < 30) and 1/5 to 1/6 of the range in large samples (N > 100).

3.2.3. 11.3.2.3 Measures of Shape

For distributions summarizing data from continuous measurement scales, statistics can be used to describe how the distribution rises and drops.

1. Symmetric: distributions that have the same shape on both sides of the center are called symmetric. A symmetric distribution with only one peak is referred to as a normal distribution.

2. Skewness: refers to the degree of asymmetry in a distribution. Asymmetry often reflects extreme scores in a distribution (Figure 24).

   a. Positively skewed - A distribution is positively skewed when it has a tail extending out to the right (larger numbers) When a distribution is positively skewed, the mean is greater than the median reflecting the fact that the mean is sensitive to each score in the distribution and is subject to large shifts when the sample is small and contains extreme scores.

   b. Negatively skewed - A negatively skewed distribution has an extended tail pointing to the left (smaller numbers) and reflects bunching of numbers in the upper part of the distribution with fewer scores at the lower end of the measurement scale.

11.5. ábra - Figure 24. Skewness graphs

![Skewness graphs]

Negatively skewed distribution or Skewed to the left
Skewness < 0

Normal distribution
Symmetrical
Skewness = 0

Positively skewed distribution or Skewed to the right
Skewness > 0
11. Analysis of data

Sources: www.medcalc.org/manual/skewnesskurtosis.php

3. Kurtosis: like skewness, kurtosis has a specific mathematical definition, but generally it refers to how scores are concentrated in the center of the distribution, the upper and lower tails (ends), and the shoulders (between the center and tails) of a distribution (Figure 25).

a. Platykurtic: starting with a mesokurtic distribution and moving scores from both the center and tails into the shoulders, the distribution flattens out and is referred to as platykurtic.

b. Mesokurtic: a normal distribution is called mesokurtic. The tails of a mesokurtic distribution are neither too thin or too thick, and there are neither too many or too few scores in the center of the distribution.

c. Leptokurtic: if you move scores from shoulders of a mesokurtic distribution into the center and tails of a distribution, the result is a peaked distribution with thick tails. This shape is referred to as leptokurtic.

11.6. ábra - Figure 25: Kurtosis graphs

Sources: www.medcalc.org/manual/skewnesskurtosis.php

3.2.4. 11.3.2.4 Using SPSS for Descriptive Statistics: The Frequency Command

Download the database: "descriptive statistics" (click on the ulink and save the data file). Started SPSS (click on Start / Programs / SPSS for Windows / SPSS 20.0 for Windows). Loaded the standard data set.

The frequencies command can be used to determine quartiles, percentiles, measures of central tendency (mean, median, and mode), measures of dispersion (range, standard deviation, variance, minimum and maximum), measures of kurtosis and skewness, and create histograms. The command is found at Analyze / Descriptive Statistics / Frequencies (this is shorthand for clicking on the Analyze menu item at the top of the window, and then clicking on Descriptive Statistics from the drop down menu, and Frequencies from the pop up menu.) (Figure 26).

11.7. ábra - Figure 26. Descriptive statistics/ The Frequency Command

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http://portal.agr.unideb.hu/oktatok/drvinczeszilvia/oktatás/oktatott_tárgyak/statisztika_kutatásmodszertan_index/index.html
11. Analysis of data

The frequencies dialog box will appear (Figure 27), and select the variable(s) (starting salary) that you want to analyze by clicking on it in the left hand pane of the frequencies dialog box. Then click on the arrow button to move the variable into the Variables pane. Be sure to select "Display frequency tables" if you want a frequency distribution. Specify which statistics you want to perform by clicking on the Statistics button. The Statistics dialog box will appear.

11.8. ábra - Figure 27. The Frequency Command/Statistics

From the statistics dialog box, click on the desired statistics that you want to perform. To calculate a given percentile, click in the box to the left of percentile(s). Type in the desired percentile and click on the Add button.
When you have selected all the desired statistics (e.g. mean, median, mode, standard deviation, variance, range, etc.), click on the Continue button.

Figure 28. The Frequency Command/Charts

Specify which chart you want to display by clicking on the Chart button. The chart dialog box will appear.

Click on the desired chart (usually Histogram) and click on the Continue button (Figure 28).

Click on OK in the frequencies dialog box. The SPSS Output Viewer will appear.

In the SPSS Output Viewer, you will see the requested statistics and chart. This is what the Statistics output looks like. It lists the requested measures of central tendency, measures of dispersion, measures of skewness and kurtosis, and the quartiles and percentiles.

The output has two columns. The left column names the statistic and the right column gives the value of the statistic. For example, the mean of this data is 17,016 (since your data set may be different, you may get a different value.) The skewness measure is greater than 0 when the distribution is skewed. The kurtosis measure is 0 for a normal distribution. Positive values imply a leptokurtic distribution, while negative values imply a platykurtic distribution (Figure 29).

11.9. ábra - Figure 29 The Frequency Command/Output
The descriptives dialog box will appear (Figure 30) and select the variable(s) that you want to analyze by clicking on it in the left hand pane of the descriptives dialog box. Then click on the arrow button to move the variable into the Variables pane:

11.10. ábra - Figure 30. Descriptive statistics/Histogram

3.2.5. 11.3.2.5 Using SPSS for Descriptive Statistics: The Descriptives Command

The descriptives command can be used to determine measures of central tendency (mean), measures of dispersion (range, standard deviation, variance, minimum and maximum), and measures of kurtosis and skewness. The command is found at Analyze / Descriptive Statistics / Descriptives (this is shorthand for clicking on the Analyze menu item at the top of the window, and then clicking on Descriptive Statistics from the drop down menu, and Descriptives from the pop up menu.). Specify which statistics you want to perform by clicking on the Options button. The Options dialog box will appear (Figure 31).

11.11. ábra - Figure 31. The Descriptives Command/Descriptive statistics
11. Analysis of data

Select the statistics that you want by clicking on them (e.g. mean, standard deviation, variance, range, minimum, etc.). Then click on the Continue button. Click on the OK button in the Descriptives dialog box. The SPSS Output Viewer will appear with your results in it. The following is an example of the output (Figure 32).

11.12. ábra - Figure 32. The Descriptives Command/Descriptive statistics/Output

3.2.6. 11.3.2.6 Using SPSS for Descriptive Statistics: The Explore Command

The explore command can be used to determine measures of central tendency (mean and median), measures of dispersion (range, interquartile range, standard deviation, variance, minimum and maximum), measures of kurtosis and skewness, and prepare histograms, stem and leaf plots, and Tukey box plots. The command is found at Analyze / Descriptive Statistics / Explore. The explore dialog box will appear and select the variable(s)
that you want to analyze by clicking on it in the left hand pane of the explore dialog box. Then click on the top arrow button to move the variable into the Dependent List (Figure 33).

### 11.13. ábra - Figure 33. The Explore Command/Explore

![Image of the Explore Command/Explore dialog box](image33.png)

Specify which plots you want to prepare by clicking on the Plots button. The Plots dialog box will appear. Select the plots that you want by clicking on them (e.g. Stem-and-leaf and histogram). (Figure 34)

### 11.14. ábra - Figure 34. The Explore Command/Explore/Plots

![Image of the Explore Command/Explore/Plots dialog box](image34.png)

Then click on the Continue button. Click on the OK button in the Explore dialog box. The SPSS Output Viewer will appear with your results in it. The following is an example of the output for the descriptive statistics (Figure 35).
11.15. ábra - Figure 35. The Explore Command/Explore/Output: Descriptives

The output gives the values of the requested statistics. If you scroll down, you will see the requested plots (Figure 36).

11.16. ábra - Figure 36. The Explore Command/Explore/Output: Stem and Leaf Plot

The Tukey box plot shows the first (bottom of box) and third (top of box) quartiles (equivalently the 25th and 75th percentiles), the median (the horizontal line in the box), the range (excluding outliers and extreme scores) (the ‘whiskers’ or lines that extend from the box show the range), outliers (a circle represents each outlier - the number next to the outlier is the observation number.) An outlier is defined as a score that is between 1.5 and 3 box lengths away from the upper or lower edge of the box (remember the box represents the middle 50 percent of the scores). An extreme score is defined as a score that is greater than 3 box lengths away from the upper or lower edge of the box. An extreme score is defined as a score that is greater than 3 box lengths away from the upper or lower edge of the box. 

*academic.udayton.edu/gregelvers/psy216/spss/descript1.htm*
11. Analysis of data

11.17. ábra - Figure 37. The Explore Command/Explore/Output: Boxplot

4. References and further reading

1. Basic Statistics: https://controls.engin.umich.edu/wiki/index.php/Basic_statistics:_mean,_median,_average,_standard_deviation,_z-scores,_and_p-value#Basic_Statistics

2. Histogram: www.businessdictionary.com/definition/histogram.html


4. Level of Measurement: en.wikipedia.org/wiki/Level_of_measurement

5. Organization of Terms: bobhall.tamu.edu/FiniteMath/Module8/Introduction.html


7. Using SPSS for Descriptive Statistics: academic.udayton.edu/gregelvers/psy216/spss/descript1.htm

8. What are Variables?: www.abs.gov.au/websitedbs/a3121120.nsf/home/statistical+language+-+what+are+variables


10. What is a variables?: www.abs.gov.au/websitedbs/a3121120.nsf/home/statistical+language+-+what+are+variables

11. What is statistics?: faculty.palomar.edu/mmumford/120/notes/Chap1.pdf

12. What is the difference between discrete data and continuous data?: stats.stackexchange.com/questions/206/what-is-the-difference-between-discrete-data-and-continuous-data

13. What are variables?: stattrek.com/descriptive-statistics/variables.aspx

5. Questions for Chapter 11
11. Analysis of data

1. What is the difference between discrete data and continuous data?
2. What are variables?
3. What are Basic Statistics?
4. What might be some interesting variables to consider about the individuals in this room?
5. Of what type is each variable?
6. How could we depict this data?
7. What kinds of questions might we ask or answer with this data?
8. What is meant by the following: Individuals and Variables?
9. What types of variables are there, and what’s the difference?
10. Is the median a datum or a statistic? Why?
11. What does the median tell you about a set of data?
12. fejezet - 12. Analysis of Variance

An important technique for analyzing the effect of categorical factors on a response is to perform an Analysis of Variance. An ANOVA decomposes the variability in the response variable amongst the different factors. Depending upon the type of analysis, it may be important to determine:

1. which factors have a significant effect on the response, and/or
2. how much of the variability in the response variable is attributable to each factor.

Statgraphics Centurion provides several procedures for performing an analysis of variance:

1. One-Way ANOVA - used when there is only a single categorical factor. This is equivalent to comparing multiple groups of data.
2. Multifactor ANOVA - used when there is more than one categorical factor, arranged in a crossed pattern. When factors are crossed, the levels of one factor appear at more than one level of the other factors.
3. Variance Components Analysis - used when there are multiple factors, arranged in a hierarchical manner. In such a design, each factor is nested in the factor above it.
4. General Linear Models - used whenever there are both crossed and nested factors, when some factors are fixed and some are random, and when both categorical and quantitative factors are present.

1. 12.1 One-Way ANOVA

The one way analysis of variance allows us to compare several groups of observations, all of which are independent but possibly with a different mean for each group. A test of great importance is whether or not all the means are equal.

The observations all arise from one of several different groups (or have been exposed to one of several different treatments in an experiment). We are classifying 'one-way' according to the group or treatment.

Conditions of use:

1. Two variables are needed. One is a variable measured on an interval or ratio scale we want to compare the means of different groups belonging to this variable. The other variable is a normal or ordinal variable, i. e. a grouping criterion which groups respondents.
2. Normality
3. Variance homogeneity

Like with two-sample t-test condition of the valid use of one-way ANOVA is normality, and variance homogeneity.

The null hypothesis claims that the means of the tested quantitative variables are the same in the populations compared.

The null hypothesis states that the means of the tested quantitative variable is the same in the populations compared.

ANOVA is robust procedure, a smaller or bigger deviation from meeting the conditions does not spoil the results.

1.1. 12.1.1 One-Way ANOVA in SPSS

A one-way analysis of variance is used when the data are divided into groups according to only one factor. The questions of interest are usually: (a) Is there a significant difference between the groups?, and (b) If so, which groups are significantly different from which others? Statistical tests are provided to compare group means,
group medians, and group standard deviations. When comparing means, multiple range tests are used, the most popular of which is Tukey's HSD procedure. For equal size samples, significant group differences can be determined by examining the means plot and identifying those intervals that do not overlap\(^1\).

Are better-educated people more attracted to culture and architecture? Hypothesis:

1. H(0): There is no difference between the groups of people with different qualifications concerning their opinions about culture and architecture as tourist attraction.

2. H(1): There is a difference between people with different qualifications concerning culture and architecture as attractions.

Open the sample data (download: ‘one-way ANOVA’\(^2\)). To perform the One-way ANOVA F-test, select the following command sequences from the SPSS Data Editor tool bar: Analyze / Compare Means / One-Way Anova…

In the One-Way ANOVA menu window, place ‘affection’ in the Dependent List box and ‘qualification’ in the Factor box, as shown below (Figure 38).

12.1. ábra - Figure 38. Analyze / Compare Means / One-Way Anova...

To complete the process described in the text, select OK in this window without doing anything else. The resulting output is the ANOVA table shown below (Figure 39).

12.2. ábra - Figure 39. Analyze / Compare Means / One-Way Anova...

\(^1\) https://statistics.laerd.com/spss-tutorials/one-way-anova-using-spss-statistics.php#procedure  
\(^2\) http://portal.agr.unideb.hu/oktatok/drinviczszilvia/oktatas/oktatott_targyak/statisztika_kutatasmodeszertan_index/index.html
12. Analysis of Variance

This duplicates the ANOVA table given in the text, with one minor difference – the column 'Sig.' provides the p-value for the test; and, since \( p < 0.05 \), the null hypothesis is rejected. As mentioned in the text, this result allows us only to conclude that at least one (true) treatment mean differs from the others; we can say nothing about the relative sizes of the (true) treatment means. Further tests can be performed to determine which treatment mean(s) differ and, consequently, determine which (true) treatment mean(s) might have the highest (or lowest) values.

The significance level of the probability belonging to a F test is lower than 0.05, so the null-hypothesis is rejected.

The categories differ from each other significantly, i. e. people with different qualifications have different attitudes towards culture.

1.1.1. 12.1.1.1 Verifying the Assumptions for the One-Way ANOVA F-test

The assumptions for the one-way ANOVA F-test, as expressed in in the text, are:

1. The populations from which the samples were obtained must be normally or approximately normally distributed.

2. The samples must be independent of one another

3. The variances of the populations must be equal.

Graphical and numerical assessments of the first and third assumptions can be performed as follows. Assessing the normality and constant variance assumptions: From the toolbar, select the commands: Analyze / Descriptive Statistics / Explore. The, assign variables as shown, and check the Plots button in the Display choices as shown below (Figure 40).

12.3. ábra - Figure 40. Analyze / Descriptive Statistics / Explore

1 uashome.alaska.edu/~cnhayjahans/Resources/SPSS/One%20Way%20ANOVA.pdf
Next, click on the Plots… button, and in the Explore: Plots window, make the choices shown below. Click on Continue, then OK in the Explore window. The first table that is of use in the resulting output is the 'Tests of Normality' table, shown below (Figure 41). This table provides results of the test of the following hypotheses:

1. \( H(0) \): The population random variable is normally distributed
2. \( H(1) \): The population random variable is not normally distributed

The results of two tests are given in this table; the one to use is the ‘Shapiro-Wilk’ test. In this case the (shaded) \( p \)-values given in the last column for ‘Bp’ values, for each of the three treatments, are large enough to conclude that the assumption of (approximate) normality of the populations from which the samples were obtained should not be rejected.

12.4. ábra - Figure 41. Analyze / Descriptive Statistics / Explore / Output – Test of Normality

The normality assumption may be assumed valid.

\[^{1}\text{uashome.alaska.edu/~cnhayjahans/Resources/SPSS/One-Way%20ANOVA.pdf}\]
The second table of use is that of the ‘Test of Homogeneity of Variances’ shown below (Figure 42). One of the assumptions of the one-way ANOVA is that the variances of the groups you are comparing are similar. The table Test of Homogeneity of Variances (see below) shows the result of Levene's Test of Homogeneity of Variance, which tests for similar variances. If the significance value is greater than 0.05 (found in the Sig. column) then you have homogeneity of variances. We can see from this example that Levene's $F$ Statistic has a significance value of 0.901 and, therefore, the assumption of homogeneity of variance is met.

12.5. ábra - Figure 42. Analyze / Descriptive Statistics / Explore / Output – Test of Homogeneity of Variance

![Test of Homogeneity of Variance Table]

What if the Levene's $F$ statistic was significant? This would mean that you do not have similar variances and you will need to refer to the Robust Tests of Equality of Means Table instead of the ANOVA Table.

The test to use here is the one that is ‘Based on Median’. This table provides results of the test of the following hypotheses:

1. $H(0)$: The population variances are equal
2. $H(1)$: The population variances are not equal.

Here too, the $p$-value given in the last column is sufficiently large to conclude the the assumption of constant variances should not be rejected. (The condition of variance homogeneity is met as: $p > 0.05$. Because the null hypothesis of the Levene-test states that the variances are not identical.)

The constant variance assumption may be assumed valid. In addition to the above tables, several scatter plots appear in the output; of these the three ‘Normal QQ Plots’ can be useful. In this case the data samples by treatments are small and the plots are not very informative.

An ideal Normal QQ Plot will have plotted points that appear to approximately fit a linear trend; a reference line will be provided by SPSS. To obtain an appropriate plot, select the toolbar commands: Graphs / Legacy Dialogs / Error bar…. Then, select Simple in the Error Bar menu window and click on the Define button (Figure 43).

12.6. ábra - Figure 43. Graphs / Legacy Dialogs / Error bar…
In the resulting Define Simple Error Bar: Summaries for Groups of Cases window, make the assignments for 'affection' for Variable, 'qualification' for Category Axis, and set the Bars Represent option to be “standard error of mean”. Use a Multiplier of 1. Click on OK to get the plot shown below (Figure 44).

12.7. ábra - Figure 44. Graphs / Legacy Dialogs / Error bar…/Output
If the error bars are close to each other in length, as appears to be the case here, one might expect the constant variance assumption to be approximately valid.

Verifying the validity of the independence assumption: The validity of the independence assumption can be difficult to assess. The best approach is to ensure that the independence of the samples is ensured by proper sampling and data collection practices.

2. 12.2 Post Hoc Tests

Recall from earlier that the ANOVA test tells you whether you have an overall difference between your groups but it does not tell you which specific groups differed - post-hoc tests do. Because post-hoc tests are run to confirm where the differences occurred between groups, they should, therefore, only be run when you have a shown an overall significant difference in group means (i.e. a significant one-way ANOVA result).

This handout provides information on the use of post hoc tests in the Analysis of Variance (ANOVA). Post hoc tests are designed for situations in which the researcher has already obtained a significant omnibus F-test with a factor that consists of three or more means and additional exploration of the differences among means is needed to provide specific information on which means are significantly different from each other.

Post-hoc tests attempt to control the experimentwise error rate usually alpha = 0.05) in the same manner that the one-way ANOVA is used instead of multiple t-tests. Post-hoc tests are termed a posteriori tests - that is, performed after the event (the event in this case being a study). (Figure 45)
12.8. ábra - Figure 45. Post Hoc test

There are a great number of different post-hoc tests that you can use, however, you should only run one post-hoc test - do not run multiple post-hoc tests. For a one-way ANOVA, you will probably find that just one of four tests need to be considered. If your data meet the assumption of homogeneity of variances then either use the Tukey's honestly significant difference (HSD) or Scheffe post-hoc tests.

Often, Tukey's HSD test is recommended by statisticians as it is not as conservative as the Scheffe test (which means that you are more likely to detect differences if they exist with Tukey's HSD test). Note that if you use SPSS, Tukey's HSD test is simply referred to as 'Tukey' in the post-hoc multiple comparisons dialogue box).

If your data did not meet the homogeneity of variances assumption then you should consider running either the Games Howell or Dunnett's C post-hoc test. The Games Howell test is generally recommended.

2.1. 12.2.1 In cased of the homogeneity of variance of the tested variables

Inspection of the source table shows that both the main effects and the interaction effect are significant. The gender effect can be interpreted directly since there are only two levels of the factor. Interpretation of either the Experience main effect or the Gender by Experience interaction is ambiguous, however, since there are multiple means in each effect. We will delay testing and interpretation of the interaction effect for a later handout. The concern now is how to determine which of the means for the four Experience groups (see table below) are significantly different from the others.

1. Fisher’s LSD (smallest significant difference): In statistics, a method for comparing treatment group means after The analysis of variance (ANOVA) null hypothesis that the expected means of all treatment groups under study are equal, has been rejected using the ANOVA F-test. If the F-test fails to reject the null hypothesis this procedure should not be used.

2. Bonferroni Test: A type of multiple comparison test used in statistical analysis. When an experimenter performs enough tests, he or she will eventually end up with a result that shows statistical significance, even if there is none. If a particular test yields correct results 99% of the time, running 100 tests could lead to a

---

1. [pages.uoregon.edu/stevensj/posthoc.pdf](pages.uoregon.edu/stevensj/posthoc.pdf)
false result somewhere in the mix. The Bonferroni test attempts to prevent data from incorrectly appearing to be statistically significant by lowering the alpha value⁴.

3. Scheffe’s Test: A statistical test that is used to make unplanned comparisons, rather than pre-planned comparisons, among group means in an analysis of variance (ANOVA) experiment. While Scheffe’s test has the advantage of giving the experimenter the flexibility to test any comparisons that appear interesting, the drawback of this flexibility is that the test has very low statistical power⁹.

4. Tukey’s test, also known as the Tukey range test, Tukey method, Tukey’s honest significance test, Tukey’s HSD (honestly significant difference) test, or the Tukey–Kramer method, is a single-step multiple comparison procedure and statistical test generally used in conjunction with an ANOVA to find which means are significantly different from one another. It compares all possible pairs of means, and is based on a studentized range distribution (q) (this distribution is similar to the distribution of t from the t-test)¹⁰.

A number of other post hoc procedures are available. There is a Tukey-Kramer procedure designed for the situation in which n-sizes are not equal. Brown-Forsythe’s post hoc procedure is a modification of the Scheffe test for situations with heterogeneity of variance. Duncan’s Multiple Range test and the Newman-Keuls test provide different critical difference values for particular comparisons of means depending on how adjacent the means are. Both tests have been criticized for not providing sufficient protection against alpha slippage and should probably be avoided. Further information on these tests and related issues in contrast or multiple comparison tests is available from Kirk (1982) or Winer, Brown, and Michels (1991)¹¹.

Open the sample data (database ‘one-way ANOVA) and click on the Post Hoc… button, then select the options indicated below (Figure 45). Click on Continue and then OK. The output includes two tables, one titled ‘Post Hoc Tests’ (Figure 46) and one ‘Homogeneous Subsets’ (Figure 47). The ’Post Hoc Tests’ table, shown below, includes the results of a simultaneous set of tests of hypotheses of the form

1. H(0) : The two means are equal
2. H(1): The two means are not equal.

Also included in this table are 95% confidence intervals for each pair of means. Relevant rows, for tests and intervals are shaded; all other rows are repetitions of these rows¹².

**12.9. ábra - Figure 46. Post Hoc test / Output / Tukey**

---

⁴ en.wikipedia.org/wiki/Bonferroni_correction
⁵ investment_terms.enacademic.com/12356/Scheffe’s_Test
⁷ pages.uoregon.edu/stevensj/posthoc.pdf
⁸ uashome.alaska.edu/~cnhayjahans/Resources/SPSS/One%20Way%20ANOVA.pdf
The 'Homogeneous Subsets' table, shown below, groups the treatments into subsets within which the treatment means are considered not significantly different.

The estimated means for the two homogeneous subsets are shaded. This table is a handy summary of the major differences among the means. It organizes the means of the three groups into "homogeneous subsets" - subsets of means that do not differ from each other at \( p < 0.05 \) go together, and subsets that do differ go into separate columns. Groups that don't show up in the same column are significantly different from each other at \( p < 0.05 \) according to the Tukey multiple comparison procedure. Notice how the "regular" group and the "fun" group show up in separate columns. This indicates that those groups are significantly different. The king-size group shows up in each column, indicating that it is not significantly different from either of the other two groups.

12.10. ábra - Figure 47. Post Hoc test / Output / Homogeneous Subsets
Homogeneous Subsets

<table>
<thead>
<tr>
<th>Qualifications</th>
<th>N</th>
<th>Subset for alpha = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Tukey HSD(^a,b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 8 primary schools</td>
<td>10</td>
<td>1.70</td>
</tr>
<tr>
<td>skilled worker</td>
<td>10</td>
<td>1.90</td>
</tr>
<tr>
<td>high school graduation</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>university</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>college</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>PhD</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>.997</td>
</tr>
<tr>
<td>Scheffe(^a,b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 8 primary schools</td>
<td>10</td>
<td>1.70</td>
</tr>
<tr>
<td>skilled worker</td>
<td>10</td>
<td>1.90</td>
</tr>
<tr>
<td>high school graduation</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>university</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>college</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>PhD</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>.064</td>
</tr>
</tbody>
</table>

Means for groups in homogeneous subsets are displayed.

\(^a\) Uses Harmonic Mean Sample Size = 9.818
\(^b\) The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

3. 12.3 Multi-Way ANOVA

When more than one factor is present and the factors are crossed, a multifactor ANOVA is appropriate. Both main effects and interactions between the factors may be estimated\(^13\).

It differs from the univariate analysis of variance in that at the same time it measures the effect of several independent variables on one dependent variable, and it also examines interaction between the independent variables.

Let us examine the interest towards cultural and architectural sights in the light of the tourist’s sex and qualification.

The conditions of the multiattribute analysis of variance completely coincide with those of the one(singl)-attribute analysis of variance.

When you choose to analyse your data using a two-way ANOVA, part of the process involves checking to make sure that the data you want to analyse can actually be analysed using a two-way ANOVA. You need to do this because it is only appropriate to use a two-way ANOVA if your data ‘passes’ six assumptions that are required for a two-way ANOVA to give you a valid result. In practice, checking for these six assumptions means that you have a few more procedures to run through in SPSS when performing your analysis, as well as spend a little bit more time thinking about your data, but it is not a difficult task. In practice, checking for these six assumptions means that you have a few more procedures to run through in SPSS when performing your analysis, as well as spend a little bit more time thinking about your data, but it is not a difficult task\(^14\).

Before we introduce you to these six assumptions, do not be surprised if, when analysing your own data using SPSS, one or more of these assumptions is violated (i.e., is not met).

\(^13\) [www.statgraphics.com/analysis_of_variance.htm](http://www.statgraphics.com/analysis_of_variance.htm)
Open the sample data (download: 'Post Hoc'\(^{15}\)). Click Analyze / General Linear Model / Univariate... on the top menu as shown below. You will be presented with the 'Univariate' dialogue box (Figure 48).

**12.11. ábra - Figure 48. Analyze / General Linear Model / Univariate...**

You need to transfer the dependent variable 'affection' into the Dependent Variable: box, and transfer both independent variables, 'sex' and 'qualification', into the Fixed Factor(s): box. You can do this by drag-and-dropping the variables into the respective boxes or by using the button. The result is shown below (For this analysis, you will not need to worry about the 'Random Factor(s)'; 'Covariate(s)' or 'WLS Weight': boxes). Click on the Plots button. You will be presented with the 'Univariate: Profile Plots' dialogue box (Figure 49).

**12.12. ábra - Figure 49. Analyze / General Linear Model / Univariate... / Plots**

\(^{15}\) http://portal.agr.unideb.hu/oktatok/drvinczeszilvia/oktatok/oktatott_targyak/statisztika_kutatasmodeszteran_index/index.html
Transfer the independent variable Edu_Level from the Factors: box into the Horizontal Axis: box, and transfer the Gender variable into the Separate Lines: box. You will be presented with the following screen. (Put the independent variable with the greater number of levels in the Horizontal Axis: box) (Figure 49). Click the button. You will see that ‘sex*qualification’ has been added to the Plots: box.

Click the button. This will return you to the 'Univariate’ dialogue box. Click the button. You will be presented with the 'Univariate: Post Hoc Multiple Comparisons for Observed...’ dialogue box, as shown below. Transfer ‘qualification’ from the Factor(s): box to the Post Hoc Tests for: box. This will make the Equal Variances Assumed- area become active (loose the ‘grey sheen’) and present you with some choices for which post-hoc test to use. For this example, we are going to select Tukey, which is a good, all-round post-hoc test. You only need to transfer independent variables that have more than two levels into the Post Hoc Tests for: box. This is why we do not transfer ‘sex’. You will finish up with the following screen (Figure 50).

12.13. ábra - Figure 50. Analyze / General Linear Model / Univariate... / Post Hoc...
Click the button to return to the 'Univariate' dialogue box. Click the button. This will present you with the 'Univariate: Options' dialogue box, as shown below. Transfer 'sex', 'qualification' and 'sex*qualification' from the Factor(s) and Factor Interactions: box into the Display Means for: box. In the -Display- area, tick the Descriptive Statistics option. You will presented with the following screen (Figure 51).

12.14. ábra - Figure 51. Analyze / General Linear Model / Univariate... / Options...
12. Analysis of Variance

Click the button to return to the "Univariate" dialogue box. Click the button to generate the output.

3.1. 12.3.1 Descriptives Table

The 'Descriptives' table is very useful because it provides the mean and standard deviation for the groups that have been split by both independent variables. In addition, the table also provides 'Total' rows, which allows means and standard deviations for groups only split by one independent variable or none at all to be known (Figure 52).

12.15. ábra - Figure 52. Analyze / General Linear Model / Univariate... / Output: Descriptives Table

---

3.2. 12.3.2 Levene’s Test of Equality of Error Variances

The variances within the group are the same that is this condition of the analysis of variance is met. The significance value for homogeneity of variances is 0 > 0.05, so the variances of the groups are not significantly different. The null hypothesis claiming equality could only be rejected with an irreleal, 39% error probability (Figure 53).

Analysis of variance is not sensitive to variance homogeneity, particularly, if the group sizes are the same.

12.16. ábra - Figure 53. Analyze / General Linear Model / Univariate... / Output: D Levene’s Test of Equality of Error Variances

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Sex</th>
<th>Mean</th>
<th>Std Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 8 primary schools</td>
<td>man</td>
<td>1.70</td>
<td>0.675</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1.70</td>
<td>0.675</td>
<td>10</td>
</tr>
<tr>
<td>skilled worker</td>
<td>man</td>
<td>1.75</td>
<td>0.707</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>women</td>
<td>2.60</td>
<td>0.707</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1.90</td>
<td>0.730</td>
<td>10</td>
</tr>
<tr>
<td>high school graduation</td>
<td>man</td>
<td>2.67</td>
<td>0.516</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>women</td>
<td>4.00</td>
<td>1.000</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3.11</td>
<td>0.928</td>
<td>9</td>
</tr>
<tr>
<td>college</td>
<td>man</td>
<td>2.50</td>
<td>0.707</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>women</td>
<td>4.13</td>
<td>0.991</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3.80</td>
<td>1.135</td>
<td>10</td>
</tr>
<tr>
<td>university</td>
<td>man</td>
<td>3.00</td>
<td>1.225</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>women</td>
<td>4.20</td>
<td>0.447</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3.60</td>
<td>1.075</td>
<td>10</td>
</tr>
<tr>
<td>PhD</td>
<td>man</td>
<td>4.33</td>
<td>1.211</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>women</td>
<td>5.00</td>
<td>0.000</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4.60</td>
<td>0.966</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>man</td>
<td>2.51</td>
<td>1.239</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>women</td>
<td>4.14</td>
<td>0.941</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3.12</td>
<td>1.378</td>
<td>59</td>
</tr>
</tbody>
</table>

Levene’s Test of Equality of Error Variances

<table>
<thead>
<tr>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>S Agu.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.036</td>
<td>10</td>
<td>48</td>
<td>.392</td>
</tr>
</tbody>
</table>

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

- Design: Intercept + qualification + sex + qualification * sex
3.3. 12.3.3 Tests of Between-Subjects Effects Table

This table shows the actual results of the two-way ANOVA (Figure 54). The significance levels of both factors are lower than the generally acceptable 0.05, therefore the null hypothesis claiming indifference is rejected. The effect of both factors upon the dependent variable is significant, however, the interaction of the two does not effect the dependent variable (p > 0.05).

The 'qualification' variable has a significant effect on the dependent variable, i.e. it is much more important than the 'sex' variable in relation to the cultural and architectural attractions.

The independent variables account for a total of 70.1% of the variance of the dependent variable, based on which it can be claimed than the two variables give a relatively good explanation to cultural and architectural attractions.

12.17. ábra - Figure 54. Analyze / General Linear Model / Univariate... / Output: Tests of Between-Subjects Effects Table

<table>
<thead>
<tr>
<th>Source</th>
<th>Type II Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>77,226a</td>
<td>10</td>
<td>7,723</td>
<td>11,253</td>
<td>.000</td>
<td>.701</td>
</tr>
<tr>
<td>Intercept</td>
<td>481,801</td>
<td>1</td>
<td>481,801</td>
<td>702,043</td>
<td>.000</td>
<td>.936</td>
</tr>
<tr>
<td>qualification</td>
<td>35,206</td>
<td>5</td>
<td>7,041</td>
<td>10,260</td>
<td>.000</td>
<td>.517</td>
</tr>
<tr>
<td>sex</td>
<td>12,109</td>
<td>1</td>
<td>12,109</td>
<td>17,645</td>
<td>.000</td>
<td>.269</td>
</tr>
<tr>
<td>qualification * sex</td>
<td>1,221</td>
<td>4</td>
<td>.305</td>
<td>.445</td>
<td>.776</td>
<td>.036</td>
</tr>
<tr>
<td>Error</td>
<td>32,942</td>
<td>48</td>
<td>.686</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>684,000</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>110,169</td>
<td>58</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[R^2 = .701 (Adjusted R^2 = .533)\]

3.4. 12.3.4 Plot of the Results

The following plot is not of sufficient quality to present in your reports, but provides a good graphical illustration of your results. In addition, we can get an idea of whether there is an interaction effect by inspecting whether the lines are parallel or not. From this plot, we can see how our results from the previous table might make sense. Remember that if the lines are not parallel\(^1\) (Figure 55).

12.18. ábra - Figure 55. Analyze / General Linear Model / Univariate... / Output: Tests of Between-Subjects Effects Table

\(^1\) statistics.laerd.com/spss-tutorials/two-way-anova-using-spss-statistics-2.php
When you have a statistically significant interaction, reporting the main effects can be misleading. Therefore, you will need to report the simple main effects.

4. References and further reading


8. International Statistitical Institution: isi.cbs.nl/glossary/


10. Scheffe’s Test: investment_terms.enacademic.com/12356/Scheffe's_Test

11. SPSS Basics for One-way ANOVA: uashome.alaska.edu/~cnhayjahans/Resources/SPSS/One%20Way%20ANOVA.pdf
5. Questions for Chapter 12

1. What does this test do?
2. When do you need to use this test?
3. What assumptions does the test make?
4. What happens if your data fail these assumptions?
5. How do you run a one-way ANOVA?
6. How do you report the results of a one-way ANOVA?
7. What are post-hoc tests?
8. Which post-hoc test should you use?
9. What is the Fisher’s LSD test?
10. What is the Bonferroni test?
11. What is the Sheffe test?
12. What is the Tukey’s test?
13. What is MANOVA?
14. Why use MANOVA?
15. What are the assumptions of MANOVA?
### 13. fejezet - 13. Correlation Analysis

Correlation is a measure of association between two variables. Correlation can tell you something about the relationship between variables. It is used to understand:

1. whether the relationship is positive or negative
2. the strength of relationship.

The variables are not designated as dependent or independent. The two most popular correlation coefficients are: Spearman's correlation coefficient rho and Pearson's product-moment correlation coefficient.

When calculating a correlation coefficient for ordinal data, select Spearman's technique. For interval or ratio-type data, use Pearson's technique.

#### 1. 13.1 Coefficient of Correlation

The value of a correlation coefficient can vary from minus one to plus one (Table 5).

<table>
<thead>
<tr>
<th>r value</th>
<th>The direction (sign) and strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 1</td>
<td>Function like linear correlation</td>
</tr>
<tr>
<td>0.7 ≤ r &lt; 1</td>
<td>Strong positive correlation</td>
</tr>
<tr>
<td>0 &lt; r &lt; 0.2</td>
<td>Weak positive correlation</td>
</tr>
<tr>
<td>r = 0</td>
<td>No linear correlation</td>
</tr>
<tr>
<td>-0.2 &lt; r &lt; 0</td>
<td>Weak negative correlation</td>
</tr>
<tr>
<td>-0.7 &lt; r ≤ 0.2</td>
<td>Moderate negative correlation</td>
</tr>
<tr>
<td>-0.2 &lt; r ≤ 0</td>
<td>Strong negative correlation</td>
</tr>
<tr>
<td>r = -1</td>
<td>Function like linear correlation</td>
</tr>
<tr>
<td>-0.2 &lt; r &lt; 0</td>
<td>Weak negative correlation</td>
</tr>
</tbody>
</table>

The stronger the association between the two variables the nearest its absolute value to 1. If r=0, then the two variables are uncorrelated (but it cannot be claimed that they are independent of each other as a different type of association may exist between them).

While ‘r’ (correlation coefficient) is a powerful tool, it has to be handled with care.

1. The most used correlation coefficients only measure linear relationship. It is therefore perfectly possible that while there is strong non linear relationship between the variables, r is close to 0 or even 0. In such a case, a scatter diagram can roughly indicate the existence or otherwise of a non linear relationship.

---

2. [explorable.com/statistical-correlation](http://explorable.com/statistical-correlation)
2. One has to be careful in interpreting the value of ‘r’. For example, one could compute ‘r’ between the size of shoe and intelligence of individuals, heights and income. Irrespective of the value of ‘r’, it makes no sense and is hence termed chance or non-sense correlation.

3. ‘r’ should not be used to say anything about cause and effect relationship. Put differently, by examining the value of ‘r’, we could conclude that variables X and Y are related. However the same value of ‘r’, does not tell us if X influences Y or the other way round. Statistical correlation should not be the primary tool used to study causation, because of the problem with third variables.

A minus one indicates a perfect negative correlation, while a plus one indicates a perfect positive correlation. A correlation of zero means there is no relationship between the two variables. When there is a negative correlation between two variables, as the value of one variable increases, the value of the other variable decreases, and vise versa. In other words, for a negative correlation, the variables work opposite each other. When there is a positive correlation between two variables, as the value of one variable increases, the value of the other variable also increases. The variables move together.

The scatterplots below show how different patterns of data produce different degrees of correlation (Figure 56).

13.1. ábra - Figure 56. Scatterplots and Correlation Coefficients

<table>
<thead>
<tr>
<th>Strong positive correlation</th>
<th>Moderate positive correlation</th>
<th>No correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Strong positive correlation" /></td>
<td><img src="image2" alt="Moderate positive correlation" /></td>
<td><img src="image3" alt="No correlation" /></td>
</tr>
<tr>
<td><img src="image4" alt="Strong negative correlation" /></td>
<td><img src="image5" alt="Moderate negative correlation" /></td>
<td><img src="image6" alt="No correlation" /></td>
</tr>
</tbody>
</table>

2. 13.2 The standard error of a correlation coefficient

The standard error of a correlation coefficient is used to determine the confidence intervals around a true correlation of zero. If your correlation coefficient falls outside of this range, then it is significantly different than zero. The standard error can be calculated for interval or ratio-type data (i.e., only for Pearson’s product-moment correlation).

3. 13.3 The significance of the correlation coefficient

---

The significance (probability) of the correlation coefficient is determined from the t-statistic. The probability of the t-statistic indicates whether the observed correlation coefficient occurred by chance if the true correlation is zero. In other words, it asks if the correlation is significantly different than zero. When the t-statistic is calculated for Spearman's rank-difference correlation coefficient, there must be at least 30 cases before the t-distribution can be used to determine the probability. If there are fewer than 30 cases, you must refer to a special table to find the probability of the correlation coefficient.

Once you've computed a correlation, you can determine the probability that the observed correlation occurred by chance. That is, you can conduct a significance test. Most often you are interested in determining the probability that the correlation is a real one and not a chance occurrence. In this case, you are testing the mutually exclusive hypotheses: $H(0): r = 0$

The easiest way to test this hypothesis is to find a statistics book that has a table of critical values of $r$. Most introductory statistics texts would have a table like this. As in all hypothesis testing, you need to first determine the significance level. Here, I'll use the common significance level of $alpha = 0.05$. This means that I am conducting a test where the odds that the correlation is a chance occurrence is no more than 5 out of 100.

### 4. 13.4 Correlation Matrix

A correlation matrix uses statistics to show the linear strength between two different sets of data. These are represented on both the axis.

### 5. 13.5 Correlation Steps Analysis

1. The analysis if outlying (boxplot): correlation analysis is very sensitive to outlying data.

2. The correlation is visualised with a scatterplot.

3. Calculation and analysis of the values.

What is the association between the income/capita (Ft) in the family and the number of guest nights spent a way from home?

#### 5.1. 13.5.1 Boxplot

A boxplot, sometimes called a box and whisker plot, is a type of graph used to display patterns of quantitative data. A boxplot splits the data set into quartiles. The body of the boxplot consists of a 'box' (hence, the name), which goes from the first quartile (Q1) to the third quartile (Q3).

Within the box, a vertical line is drawn at the Q2, the median median of the data set. Two horizontal lines, called whiskers, extend from the front and back of the box. The front whisker goes from Q1 to the smallest non-outlier in the data set, and the back whisker goes from Q3 to the largest non-outlier (Figure 57).

#### 13.2. ábra - Figure 57. Boxplot

Sources: stattrek.com/statistics/dictionary.aspx?definition=boxplot

---

If the data set includes one or more outliers, they are plotted separately as points on the chart. In the boxplot above, two outliers precede the first whisker; and three outliers follow the second whisker.

In statistics, an outlier is an observation that is numerically distant from the rest of the data. Grubbs\(^6\) defined an outlier as: An outlying observation, or outlier, is one that appears to deviate markedly from other members of the sample in which it occurs\(^7\).

Open the sample data (database ‘boxplot’). We then choose the Analyze menu. This opens a sub-menu window from which we can choose a Explore sub-menu. This opens a window that allows us to select variables to have boxplots made for.

In this case, I chose the variable “guestnight” to make a boxplot of and I chose to label the cases by “cases” (which is important for outliers in a boxplot). I chose Plots only in order not to get statistics too. We then click the Plot button (circled above) to choose box plots. This gives the window (Figure 58).

I chose Boxplots (don’t worry that it is ‘Factor levels together’ for now. Notice I could also have hosen to get a stem and leaf display or a histogram at this same point to further explore my data. You then click Continue (or its equivalent) to close the Plots window and then OK (or its equivalent) to close the explore window and start computation of the boxplot\(^8\). Download the data base ‘correlate’.

**13.3. ábra - Figure 58. Boxplot: Analyze / Descriptive Statistics / Explore… / Plots**

![Boxplot window](image)

The results will appear in the .spo window after a time (Figure 59).

**13.4. ábra - Figure 59. Boxplot: Analyze / Descriptive Statistics / Explore…**

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\(^{7}\) en.wikipedia.org/wiki/Outlier

\(^{8}\) www.math.ou.edu/~mcknight/4753/spss/SPSS6.pdf

\(^{9}\) http://portal.agr.unideb.hu/oktatok/drvinczeszilvia/oktatas/oktatott_targyak/statisztika_kutatasmodoszertan_index/index.html
As in all box plots, the top of the box represents the 75th percentile, the bottom of the box represents the 25th percentile, and the line in the middle represents the 50th percentile. The whiskers (the lines that extend out the top and bottom of the box) represent the highest and lowest values that are not outliers or extreme values. Outliers (values that are between 1.5 and 3 times the interquartile range) and extreme values (values that are more than 3 times the interquartile range) are represented by circles beyond the whiskers.

Notice that outliers are suspect outliers are indicated by asterisks and very suspect outliers by circles.

5.2. 13.5.2 Scatter Plot

A scatter plot or scattergraph is a type of mathematical diagram using Cartesian coordinates to display values for two variables for a set of data. The data is displayed as a collection of points, each having the value of one variable determining the position on the horizontal axis and the value of the other variable determining the position on the vertical axis. This kind of plot is also called a scatter chart, scattergram, scatter diagram, or scatter graph. A scatter plot is used when a variable exists that is under the control of the experimenter. If a parameter exists that is systematically incremented and/or decremented by the other, it is called the control parameter or independent variable and is customarily plotted along the horizontal axis. The measured or dependent variable is customarily plotted along the vertical axis. If no dependent variable exists, either type of variable can be plotted on either axis and a scatter plot will illustrate only the degree of correlation (not causation) between two variables.

To produce a scatter plot, click Graphs / Legacy Dialogs / Scatter/Dot ... This tutorial demonstrates a plot of 5 continuous variables.

There are several types of scatter plots that you can prepared. The Simple scatter plot allows you to plot one variable as a function of another. It the most frequently used type of scatter plot for simple correlation and linear regression. The Matrix scatter plot allows you to plot several simple scatter plots organized in a matrix. This is useful when you want to show all possible scatter plots for a combination of variables. The Overlay scatter plot allows you to plot several variables as a function of another single variable. The 3D scatter plot allows you to three dimensional (i.e. 3 variable) scatter plots. Select the type of scatter plot that you want by clicking on

---

10 en.wikipedia.org/wiki/Scatter_plot
11 en.wikipedia.org/wiki/Scatter_plot
appropriate icon (in this example Simple) and click on the Define button\(^2\). The Simple Scatter Plot dialog box appears (Figure 60).

**13.5. ábra - Figure 60. Scatter Plot: Graphs / Legacy Dialogs / Scatter/Dot…**

[Image of Scatter Plot dialog box]

In the left panel, click on the variable that you want plotted on the Y axis, and move it into the Y axis box by clicking on the arrow button to the left of the Y axis box. In the left panel, click on the variable that you want plotted on the X axis, and move it into the X axis box by clicking on the arrow button to the left of the X axis box. In this example, I have decided to plot the Friends variable on the Y axis and the Extravert variable on the X axis (Figure 61).

**13.6. ábra - Figure 61. Scatter Plot: Graphs / Legacy Dialogs / Scatter/Dot / Simple**

\(^2\) academic.udayton.edu/gregelvers/psy216/spss/graphs.htm
Click on the OK button in the Simple Scatter Plot dialog box. The scatter plot will appear in the SPSS Output Viewer (Figure 62). The scatter plot the finger justifies our preliminary assumption that above 50,000 Ft income the points are located along a straight with a positive steepness.

13.7. ábra - Figure 62: Scatter Plot: Graphs / Legacy Dialogs / Scatter/Dot / Simple

5.2.1. 13.5.2.1 Bivariate Correlation

Bivariate correlation can be used to determine if two variables are linearly related to each other. Remember that you will want to perform a scatter plot before performing the correlation (to see if the assumptions have been
met.) Open the data set: 'correlate'. The command for correlation is found at Analyze / Correlate / Bivariate. The Bivariate Correlations dialog box will appear (database 'boxplot'). Select one of the variables that you want to correlate by clicking on it in the left hand pane of the Bivariate Correlations dialog box. Then click on the arrow button to move the variable into the Variables pane. Click on the other variable that you want to correlate in the left hand pane and move it into the Variables pane by clicking on the arrow button (Figure 63).

13.8. ábra - Figure 63. Analyze / Correlate / Bivariate

Specify whether the test of significance should be one-tailed or two-tailed. (We won't get to this topic for quite a while. For now, select the one-tailed test by clicking on the circle to the left of 'one-tailed'.) You can click on the Options button to have some descriptive statistics calculated. The Options dialog box will appear (Figure 64).

13.9. ábra - Figure 64. Analyze / Correlate / Bivariate Correlation / Options
13. Correlation Analysis

From the Options dialog box, click on ‘Means and standard deviations’ to get some common descriptive statistics. Click on the Continue button in the Options dialog box. Click on OK in the Bivariate Correlations dialog box. The SPSS Output Viewer will appear.

In the SPSS Output Viewer, you will see a table with the requested descriptive statistics and correlations. This is what the Bivariate Correlations output looks like (Figure 65).

13.10. ábra - Figure 65. Analyze / Correlate / Bivariate Correlation / Output

The Descriptive Statistics section gives the mean, standard deviation, and number of observations (N) for each of the variables that you specified. For example, the mean of the extravert variable is 7.4, the standard deviation of the rather stay at home variable is 14635.8, and there were 50 observations (N) for each of the two variables.
The second table analysis is symmetrical, the examination of one cell is enough. The value of the correlation coefficient is 0.835 which means a positive strong correlation. The number of items in the samples is 50. Correlation is significant at the 0.01 level.

6. References and further reading

5. Outlier: en.wikipedia.org/wiki/Outlier
8. SPSS Graphs: academic.udayton.edu/gregelvers/psy216/spss/graphs.htm

7. >Questions for Chapter 13

1. What is correlation analysis?
2. When can correlation analysis be applied?
3. What values can Pearson correlation coefficient take?
4. What is a correlation matrix?
5. How do I interpret data in SPSS for Pearson's r and scatterplots?
14. Regression Analysis

In statistics, regression analysis is a statistical technique for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps one understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables — that is, the average value of the dependent variable when the independent variables are fixed. Less commonly, the focus is on a quantile, or other location parameter of the conditional distribution of the dependent variable given the independent variables.

A regression equation allows us to express the relationship between two (or more) variables algebraically. It indicates the nature of the relationship between two (or more) variables. In particular, it indicates the extent to which you can predict some variables by knowing others, or the extent to which some are associated with others.

If there is a stochastic association between the two variables, a regression analysis can be made, which can also provide information about the strength and direction of the association. Both variables must be measured on an interval or a ratio scale.

1. Ratio scale e.g. the income the number of guest nights spent.
2. Interval scale: satisfaction (Likert-scale)²

Linear Regression estimates the coefficients of the linear equation, involving one or more independent variables that best predict the value of the dependent variable.

Linear regression attempts to fit a linear straight on the data.

1. It estimates the parameters of the straight.
2. The equation of the straight is \( y = mx + b \), where ‘m’ means the steepness of the straight, and ‘b’ is the constant, i.e. where the straight intersects the y axis.

It provides information about the strength of the association using the determination coefficient (r²)

1. The value of r² ranges between 0 and 1. The bigger is its value, the stronger is the stochastic association between the two variables.
2. It shows what quotient of variance of the dependent (y) variable is explained by the independent (x) variable.

The values of ‘m’ and ‘b’ of the linear system of equations are estimated using the method of smallest squares.

1. Those parameters are looked for which give a straight whose distance from the particular points is the smallest possible.
2. The square sums of the particular points and of the distance of the os the straight must be minimized to these.

A regression line is a line drawn through the points on a scatterplot to summarise the relationship between the variables being studied. When it slopes down (from top left to bottom right), this indicates a negative or inverse relationship between the variables; when it slopes up (from bottom right to top left), a positive or direct relationship is indicated.

The regression line often represents the regression equation on a scatterplot.

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1. en.wikipedia.org/wiki/Regression_analysis
2. Likert-scale: A method of ascribing quantitative value to qualitative data, to make it amenable to statistical analysis. A numerical value is assigned to each potential choice and a mean figure for all the responses is computed at the end of the evaluation or survey.
Simple linear regression aims to find a linear relationship between a response variable and a possible predictor variable by the method of least squares.

Multiple linear regression aims is to find a linear relationship between a response variable and several possible predictor variables.

Nonlinear regression aims to describe the relationship between a response variable and one or more explanatory variables in a non-linear fashion.

The multiple regression correlation coefficient, $R^2$, is a measure of the proportion of variability explained by, or due to the regression (linear relationship) in a sample of paired data. It is a number between zero and one and a value close to zero suggests a poor model. A very high value of $R^2$ can arise even though the relationship between the two variables is non-linear. The fit of a model should never simply be judged from the $R^2$ value.

A 'best' regression model is sometimes developed in stages. A list of several potential explanatory variables are available and this list is repeatedly searched for variables which should be included in the model. The best explanatory variable is used first, then the second best, and so on. This procedure is known as stepwise regression.

1. 14.1 Analysing data in SPSS using regression analysis

Open the sample data (download: 'linear regression”). Remember that you will want to perform a scatterplot and correlation before you perform the linear regression (to see if the assumptions have been met.) (Graphs / Legacy Diologs / Scatter/Dot…) (Figure 66).

14.1. ábra - Figure 66. Graphs / Legacy Diologs / Scatter/Dot…

1 http://portal.agr.unideb.hu/oktatok/drvinczeszilvia/oktatas/oktatott_targyak/statisztika_kutatasmodszertan_index/index.html
Data above 650 mmm should be ignored, data must be filtered, use the filter command in SPSS.

1.1. 14.1.1 Select Cases

The Select Cases command excludes from further analysis all those cases that do not meet specified selection criteria (Table 6) (Figure 67).

### 14.1. táblázat - Table 6. The Select Cases If command

<table>
<thead>
<tr>
<th>SPSS command/action</th>
<th>Comment</th>
<th>SPSS command/action</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Select Data/Select Cases This brings up the Select Cases dialog box</td>
<td></td>
<td>1 Select Data/Select Cases This brings up the Select Cases dialog box</td>
<td></td>
</tr>
<tr>
<td>2 Click on the radio button next to If condition is satisfied</td>
<td>The default setting is for SPSS to use all cases. By clicking on the radio button we are instructing SPSS that only a subset of cases will be used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Click on the If condition is satisfied button</td>
<td>This brings up the Select Cases: If dialog box</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 In the source variable list select the variable whose values will act as the filter.</td>
<td>This pastes the selected variable in the area where the filter criteria are determined</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6 From the calculator pad in the box, or from the keyboard, select ≤ 650

This instructs SPSS to select all those cases whose value ≤ 650 mm

7 Click Continue

8 Click OK

Sources: www.arts.unsw.edu.au/gargyrous/extra_chapters/SPSSSelectCasesCommand.pdf

14.2. ábra - Figure 67. The SPSS Select Cases command, the Select Cases and the Select Cases: If dialog box

There are a number of other criteria by which cases can be selected, which are summarized in the Figure 68.

14.3. ábra - Figure 68: Overview of the Select Cases dialog box
The effect of this will be to create a new variable as the last column in the Data Editor. This variable is labelled filter_\$ (Figure 69).

Cases will be given a value of 0 (Not Selected) for this filter variable if they do not conform to the filtering criteria used in the Select Cases command and a value of 1 (Selected) if they do fulfil the selection criteria.

14.4. ábra - Figure 69. The Data Editor with filter variable
14. Regression Analysis

You will also notice that those cases for whom the selection criterion is not true will have a slash mark through their respective row numbers, indicating that they will not be used in any subsequent analysis.

2. 14.2 Linear Regression

In a cause and effect relationship, the independent variable is the cause, and the dependent variable is the effect. Least squares linear regression is a method for predicting the value of a dependent variable \( Y \), based on the value of an independent variable \( X \). In this tutorial, we focus on the case where there is only one independent variable. This is called simple regression (as opposed to multiple regression, which handles two or more independent variables).

Simple linear regression is appropriate when the following conditions are satisfied:

1. The dependent variable \( Y \) has a linear relationship to the independent variable \( X \). To check this, make sure that the XY scatterplot is linear and that the residual plot shows a random pattern.

2. For each value of \( X \), the probability distribution of \( Y \) has the same standard deviation \( \sigma \). When this condition is satisfied, the variability of the residuals will be relatively constant across all values of \( X \), which is easily checked in a residual plot.

3. For any given value of \( X \),
   a. The \( Y \) values are independent, as indicated by a random pattern on the residual plot.
   b. The \( Y \) values are roughly normally distributed (i.e., symmetric and unimodal). A little skewness is ok if the sample size is large. A histogram or a dotplot will show the shape of the distribution.

Linear regression is used to specify the nature of the relation between two variables. Another way of looking at it is, given the value of one variable (called the independent variable in SPSS), how can you predict the value of

\[
\text{stattrek.com/regression/linear-regression.aspx}\]
\[
\text{stattrek.com/regression/linear-regression.aspx}\]
some other variable (called the dependent variable in SPSS)? Remember that you will want to perform a scatterplot and correlation before you perform the linear regression (to see if the assumptions have been met)\(^6\) (Figure 70).

14.5. ábra - Figure 70. Scatter Plot

The linear regression command is found at Analyze / Regression / Linear (this is shorthand for clicking on the Analyze menu item at the top of the window, and then clicking on Regression from the drop down menu, and Linear from the pop up menu). The Linear Regression dialog box will appear (Figure 71).

14.6. ábra - Figure 71. Analyze / Regression / Linear…

\(^6\) academic.udayton.edu/gregelvers/psy216/SPSS/reg.htm
Select the variable that you want to predict by clicking on it in the left hand pane of the Linear Regression dialog box. Then click on the top arrow button to move the variable into the Dependent box. Select the single variable that you want the prediction based on by clicking on it is the left hand pane of the Linear Regression dialog box. (If you move more than one variable into the Independent box, then you will be performing multiple regression. While this is a very useful statistical procedure, it is usually reserved for graduate classes.) Then click on the arrow button next to the Independent(s) box. You can request SPSS to print descriptive statistics of the independent and dependent variables by clicking on the Statistics button. This will cause the Statistics Dialog box to appear.

You can request SPSS to print descriptive statistics of the independent and dependent variables by clicking on the Statistics button. This will cause the Statistics Dialog box to appear (Figure 72).

14.7. ábra - Figure 72. Analyze / Regression / Linear…/ Statistics
Click in the box next to Descriptives to select it. Click on the Continue button. In the Linear Regression dialog box, click on OK to perform the regression.

The SPSS Output Viewer will appear with the output. The Descriptive Statistics part of the output gives the mean, standard deviation, and observation count (N) for each of the dependent and independent variables. (Figure 73).

14.8. ábra - Figure 73. Analyze / Regression / Linear regression / Output: Descriptive Statistics

Regression

[DataSet1] G:\2013\EsESEARCH mETHODOLOGY\liner regression.sav

<table>
<thead>
<tr>
<th>Description Statistics</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>crop (t/ha)</td>
<td>5.0780</td>
<td>1.01959</td>
<td>10</td>
</tr>
<tr>
<td>precipitation (mm)</td>
<td>493.30</td>
<td>86.398</td>
<td>10</td>
</tr>
</tbody>
</table>

The Correlations part of the output shows the correlation coefficients. This output is organized differently than the output from the correlation procedure. The first row gives the correlations between the independent and dependent variables. The next row gives the significance of the correlation coefficients. See the discussion in the correlation tutorial to interpret this. As before, it is unlikely that we would observe correlation coefficients this large if there were no linear relation between rather stay at home and extravert. The last row gives the number of observations for each of the variables, and the number of observations that have values for all the independent and dependent variables' (Figure 74).
14.9. ábra - Figure 74. Analyze / Regression / Linear regression / Output: Correlations

<table>
<thead>
<tr>
<th>Correlations</th>
<th>crop (t/ha)</th>
<th>precipitation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>1,000</td>
<td>0,943</td>
</tr>
<tr>
<td></td>
<td>0,943</td>
<td>1,000</td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>crop (t/ha)</td>
<td>precipitation (mm)</td>
</tr>
<tr>
<td></td>
<td>0,000</td>
<td>.</td>
</tr>
<tr>
<td>N</td>
<td>crop (t/ha)</td>
<td>precipitation (mm)</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

The Variables Entered/Removed part of the output simply states which independent variables are part of the equation (extravert in this example) and what the dependent variable is ("I'd rather stay at home than go out with my friends" in this example.) (Figure 75)

14.10. ábra - Figure 75. Analyze / Regression / Linear regression / Output: Variables Entered/Removed

<table>
<thead>
<tr>
<th>Variables Entered/Removed²</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Variables Entered</td>
</tr>
<tr>
<td>1</td>
<td>precipitation (mm)</td>
</tr>
</tbody>
</table>

The Model Summary part of the output is most useful when you are performing multiple regression (which we are NOT doing.) Capital R is the multiple correlation coefficient that tells us how strongly the multiple independent variables are related to the dependent variable. In the simple bivariate case (what we are doing) $R = | r |$ (multiple correlation equals the absolute value of the bivariat correlation.) $R^2$ square is useful as it gives us the coefficient of determination.

This table provides the R and $R^2$ value. The R value is 0.943, which represents the simple correlation. It indicates a high degree of correlation. The $R^2$ value indicates how much of the dependent variable, can be explained by the independent variable. In this case, 87.6 % can be explained, which is very large (Figure 76).

14.11. ábra - Figure 76. Analyze / Regression / Linear regression / Output: Model Summary

The standard error of the estimate: it provides help in establishing the exactness of the prediction. If its value is high, the prediction is imprecise, the prediction does not estimate well.

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* [academic.udayton.edu/gregelvers/psy216/SPSS/reg.htm](http://academic.udayton.edu/gregelvers/psy216/SPSS/reg.htm)
The ANOVA part of the output is not very useful for our purposes. It basically tells us whether the regression equation is explaining a statistically significant portion of the variability in the dependent variable from variability in the independent variables.

This table indicates that the regression model predicts the outcome variable significantly well. How do we know this? Look at the 'Regression' row and go to the Sig. column. This indicates the statistical significance of the regression model that was applied. Here, p < 0.0005 which is less than 0.05 and indicates that, overall, the model applied is significantly good enough in predicting the outcome variable (Figure 77).

14.12. ábra - Figure 77. Analyze / Regression / Linear regression / Output: ANOVA

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>8,323</td>
<td>1</td>
<td>8,323</td>
<td>64,458</td>
<td>0,000*</td>
</tr>
<tr>
<td>Residual</td>
<td>1,033</td>
<td>8</td>
<td>.129</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9,356</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), precipitation (mm)
b. Dependent Variable: crop (t/ha)

The Coefficients part of the output gives us the values that we need in order to write the regression equation. The regression equation will take the form: Predicted variable (dependent variable) = slope * independent variable + intercept. The slope is how steep the line regression line is. A slope of 0 is a horizontal line, a slope of 1 is a diagonal line from the lower left to the upper right, and a vertical line has an infinite slope. The intercept is where the regression line strikes the Y axis when the independent variable has a value of 0 (Figure 78).

14.13. ábra - Figure 78. Analyze / Regression / Linear regression / Output: Coefficients

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>.094</td>
<td>.632</td>
<td>.134</td>
<td>.097</td>
</tr>
<tr>
<td>precipitation (mm)</td>
<td>.010</td>
<td>.061</td>
<td>8,029</td>
<td>.003</td>
</tr>
</tbody>
</table>

a. Dependent Variable: crop (t/ha)

This section shows you the beta coefficients for the actual regression equation. Usually, you want the 'unstandardized coefficients', because this section includes a y-intercept term (beta zero) as well as a slope term (beta one). The "standardized coefficients" are based on a re-scaling of the variables so that the y-intercept is equal to zero.

Predicted value $y = 0.084 + 0.01 \times \text{precipitation}$.

3. References and further reading

2. Regression Analysis: en.wikipedia.org/wiki/Regression_analysis
3. SPSS Web Books Regression with SPSS: www.ats.ucla.edu/stat/spss/webbooks/reg/default.htm
4. Selecting a sub-set of cases in SPSS:

*a academic.udayton.edu/gregelvers/psy216/SPSS/reg.htm
**academic.udayton.edu/gregelvers/psy216/SPSS/reg.htm


7. Using SPSS for Linear Regression: academic.udayton.edu/gregelvers/psy216/SPSS/reg.htm


**4. Questions for Chapter 14**

1. What is
   a. a regression analysis?
   b. a stochastic association?
   c. linear regression?
   d. a regression line?
   e. a multiple regression correlation coefficient?

2. What does
   a. „Modell Summary” table show?
   b. „ANOVA” table show?
   c. „Coefficient” table show?
15. fejezet - 15. Generalization, interpretation And preparation of the report

Generalization, which is an act of reasoning that involves drawing broad inferences from particular observations, is widely-acknowledged as a quality standard in quantitative research, but is more controversial in qualitative research. The goal of most qualitative studies is not to generalize but rather to provide a rich, contextualized understanding of some aspect of human experience through the intensive study of particular cases. The goal of most qualitative studies is not to generalize but rather to provide a rich, contextualized understanding of some aspect of human experience through the intensive study of particular cases. Yet, in an environment where evidence for improving practice is held in high esteem, generalization in relation to knowledge claims merits careful attention by both qualitative and quantitative researchers. Issues relating to generalization are, however, often ignored or misrepresented by both groups of researchers. Three models of generalization:

1. Statistical generalization involves inferring the results from a sample and applying it to a population. To do this, the sample must be selected randomly and be representative of the population. It is important that the characteristics and units of the population (e.g., individuals, households) are specified before a sample is drawn. Scientific generalizability within case study research has often been challenged. Some scholars argue that statistical generalization is often not as relevant for case studies because the sample sizes are typically quite small and are often not representative of the population. For this reason, theoretical generalization is often used in case studies in which a previously developed theory is used as a template against which one can compare the empirical results of the case study. With this in mind, caution should be used when applying statistical generalization to case studies. In order to statistically generalize the findings of a research.

2. Analytic Generalization: Also called theoretical elaboration, this is a type of generalization in which the inquirer attempts to link findings from a particular case to a theory. (Here theory means something more like a set of theoretical tools, models, or concepts rather than a formalized set of propositions, laws, and generalizations.

3. Transferability is applied by the readers of research. Although generalizability usually applies only to certain types of quantitative methods, transferability can apply in varying degrees to most types of research. Unlike generalizability, transferability does not involve broad claims, but invites readers of research to make connections between elements of a study and their own experience. For instance, teachers at the high school level might selectively apply to their own classrooms results from a study demonstrating that heuristic writing exercises help students at the college level.

Generalizability and transferability are important elements of any research methodology, but they are not mutually exclusive: generalizability, to varying degrees, rests on the transferability of research findings. It is important for researchers to understand the implications of these twin aspects of research before designing a study. Researchers who intend to make a generalizable claim must carefully examine the variables involved in the study. Among these are the sample of the population used and the mechanisms behind formulating a causal model. Furthermore, if researchers desire to make the results of their study transferable to another context, they must keep a detailed account of the environment surrounding their research, and include a rich description of that environment in their final report. Armed with the knowledge that the sample population was large and varied, as well as with detailed information about the study itself, readers of research can more confidently generalize and transfer the findings to other situations.

1. 15.1 Generalization
Generalization is an essential component of the wider scientific process. In an ideal world, to test a hypothesis, you would sample an entire population. You would use every possible variation of an independent variable. In the vast majority of cases, this is not feasible, so a representative group is chosen to reflect the whole population.

For any experiment, you may be criticized for your generalizations about sample, time and size. You must ensure that the sample group is as truly representative of the whole population as possible. For many experiments, time is critical as the behaviors can change yearly, monthly or even by the hour. The size of the group must allow the statistics to be safely extrapolated to an entire population (Figure 79).

15.1. ábra - Figure 79. Generalization in Research

There are three types of generalizability that interact to produce probabilistic models. All of them involve generalizing a treatment or measurement to a population outside of the original study. Researchers who wish to generalize their claims should try to apply all three forms to their research, or the strength of their claims will be weakened (Runkel & McGrath, 1972).

In one type of generalizability, researchers determine whether a specific treatment will produce the same results in different circumstances. To do this, they must decide if an aspect within the original environment, a factor beyond the treatment, generated the particular result. This will establish how flexibly the treatment adapts to new situations. Higher adaptability means that the treatment is generalizable to a greater variety of situations. To responsibly generalize that this heuristic is effective, a researcher would need to test the same prewriting exercise in a variety of educational settings at the college level, using different teachers, students, and environments. If the same positive results are produced, the treatment is generalizable.

A second form of generalizability focuses on measurements rather than treatments. For a result to be considered generalizable outside of the test group, it must produce the same results with different forms of measurement. In terms of the heuristic example above, the findings will be more generalizable if the same results are obtained when assessed "with questions having a slightly different wording, or when we use a six-point scale instead of a nine-point scale" (Runkel & McGrath, 1972, p.46).

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* explorable.com/what-is-generalization

writing.colostate.edu/guides/page.cfm?pageid=1373
A third type of generalizability concerns the subjects of the test situation. Although the results of an experiment may be internally valid, that is, applicable to the group tested, in many situations the results cannot be generalized beyond that particular group. Researchers who hope to generalize their results to a larger population should ensure that their test group is relatively large and randomly chosen. However, researchers should consider the fact that test populations of over 10,000 subjects do not significantly increase generalizability (Firestone, 1993).

2. 15.2 Interpretation

After collecting and analyzing the data, the researcher has to accomplish the task of drawing inferences followed by report writing. This has to be done very carefully, otherwise mi conclusions may be drawn and the whole purpose of doing research may get vitiated. It is only through interpretation that the researcher can expose relations and processes that underlie his findings (Figure 80).

15.2. ábra - Figure 80. Interpretation and Containment

In case of hypotheses testing studies, if hypotheses are tested and upheld several times, the researcher may arrive at generalizations. But in case the researcher had no hypothesis to start with, he would try to explain his findings on the basis of some theory. This may at times result in new questions, leading to further researches. All this analytical information and consequential inference(s) may well be communicated, preferably through research report, to the consult of research results who may be either an individual or a group of individuals or some public private organisation.

2.1. 15.2.1 Meaning of Interpretation

Interpretation refers to the task of drawing inferences from the collected facts after an analytical and or experimental study. In fact, it is a search for broader meaning of research findings. The task of interpretation has two major aspects viz.,

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8 www.kish.in/interpretation_and_report_writing/ (15.2 Chapter)
1. the effort to establish continuity in research through unlinking the results of a given study with those of another, and

2. the establishment of some explayfat concepts. “In one sense, interpretation is concerned with relationships within the collected data, partially overlapping analysis. Interpretation also extends beyond the data of the study to inch the results of other research, theory and hypotheses.” Thus, interpenetration is the device through which the factors that seem to explain what has been observed by researcher in the course of the study can be better understood and it also provides a theoretical conception which can serve as a guide for further researches.

2.2. 15.2.2 Why Interpretation?

Interpretation is essential for the simple reason that the usefulness and utility of research findings lie in proper interpretation. It is being considered a basic component of research process because of the following reasons:

1. It is through interpretation that the researcher can well understand the abstract principle that works beneath his findings. Through this he can unlink up his findings with those of other studies, having the same abstract principle, and thereby can predict about the concrete world of events. Fresh inquiries can test these predictions later on. This way the continuity in research can be maintained.

2. Interpretation leads to the establishment of explanatory concepts that can serve as a guide for future research studies; it opens new avenues of intellectual adventure and stimulates the quest for more knowledge.

3. Researcher can better appreciate only through interpretation why his findings are what they are and can make others to under-stand the real significance of his research findings.

4. The interpretation of the findings of exploratory research study often results into hypotheses for experimental research and as such interpretation is involved in the transition from exploratory to experimental research. Since an exploratory study does not have a hypothesis to start with, the findings of such a study have to be interpreted on a post factum basis in which case the interpretation is technically described as ‘post factum’ interpretation.

2.3. 15.2.3 Technique of Interpretation

The task of interpretation is not an easy job, rather it requires a great skill and dexterity on the part of researcher. Interpretation is an art that one learns through practice and experience. The researcher may, at times, seek the guidance from experts for accomplishing the task of interpretation. The technique of interpretation often involves the following steps:

1. Researcher must give reasonable explanations of the relations which he has found and he must interpret the lines of relationship in terms of the underlying processes and must try to find out the thread of uniformity that lies under the surface layer of his diversified research findings. In fact, this is the technique of how generalization should be done and concepts be formulated.

2. Extraneous information, if collected during the study, must be considered while interpreting the final results of research study, for it may prove to be a key factor in understanding the problem under consideration.

3. It is advisable, before embarking upon final interpretation, to consult someone having insight into the study and who is frank and honest and will not hesitate to point out omissions and errors in logical argumentation. Such a consultation will result in correct interpretation and, thus, will enhance the utility of research results.

4. Researcher must accomplish the task of interpretation only after considering all relevant factors affecting the problem to avoid false generalization. He must be in no hurry while interpreting results, for quite often the conclusions, which appear to be all right at the beginning, may not at all be accurate.

3. 15.3 Preparation of the report

Oral presentation of the report is the final stage of the research, and its purpose is to convey to the intended audience the whole result of the study in sufficient details and to enable each user of research to comprehend the data and to determine for himself the validity of the conclusion. Presentation has become increasingly essential
medium of communication, because report is better understood, if it is accompanied by a presentation. The intended audience can interact with the researcher(s) and share the research process that the researcher(s) has gone through in developing the report.9

3.1. 15.3.1 Technique of Interpretation10

Presentation of report is essential because it helps in:

1. Better understanding of the contents of the report.
2. Improved persuasion and decision making.
3. Entering into a dialogue with the author(s) of the report for clarification of points/doubts.
4. Achieving change in attitude or behavior of the audience

3.2. 15.3.2 Presentation of research report to technical person11

The scientific researcher has to present the findings of his research report, basically to the technical personnel. The findings of business research are meant for managers. Sometimes, before the presentation of the research findings, the investigator discusses his findings with other scholars. In many cases the discussion is done before the research project has been evolved. So the basic aim of the presentation of the research findings is to make the results available to the peer group of scientists.

For presenting research to a scientific audience, a set of customary procedures have been developed, which considerably facilitate presentation. Such presentation begins as a rule, with the statement of the problem and its relation to theoretical propositions. This is followed by a description of the research design and discussion of the methods of the data collected which have been used. In such cases, the results are presented with an indication of the nature of the analysis which has been performed. In a final section, the results which bear any relation to the original hypothesis, and conclusions are drawn together with their bearing on theoretical precepts.

3.3. 15.3.3 Presentation skill set12

Presentation skills include that ability to mix in the right proportion various elements of:

1. Communication Issues
2. Presentation Handouts
3. Use of audio-visual aids to achieve the interaction with intended audience.

3.3.1. 15.3.3.1 Communication Issues

The main components of communication issues, which are relevant to a presentation are:

1. Aim: The first step to know the clear aim of the presentation and then be able to focus the presentation sharply to achieve this aim. Different types of research reports have different aims. For example a market research report may be presented by a manufacturer to a group of intended distributors with an aim to enthuse them to become the channel partners. In this scenario, first market information is provided to them. Then in the light of research findings they are motivated to sign up as distributors. This implies that a decision making process has been achieved. Such a presentation, therefore, needs to be sharpened by emphasizing on benefits to the distributors and exhorting upon the virtues of the product.

2. Audience: Is another important parameter in the presentation process. Though research presentations are for intended audience, at times audience interest can wane if the presentation becomes a monologue. The presentation must keep the audience interest alive by having a suspense dimension in the presentation or by having interesting anecdotes interspersed in the presentation.
3. Multimedia: In today’s world multiple medium have merged to give rise to multimedia presentation technology. Here a judicious mixture of visuals, animations, audio and graphics is done to heighten the sensory impact of presentation to the audiences.

4. Time and Place: Time and place of presentation are also very important. Today breakfast presentation is becoming very popular as mind is very fresh in the early morning and perceptive to new ideas. Late evenings are more suited to corporate presentation which could be followed by business socializing over cocktails and dinner. Place is determined by the size of audience and presentation technology being utilized. Obviously large audience would require larger halls and so would television projection systems. Acoustics and seating arrangements also play an important part in determining the use of audio-visual aids.

3.3.2. 15.3.3.2 Presentation Handouts / Give-aways

The presentations are accompanied by handouts and give-aways to strengthen the impact of presentation.

1. Pre-presentation handouts: These include company/research background. Summary of detailed speech, data tables, etc which audience can refer to during actual presentations.

2. Post-presentation handouts: These generally include photocopies of Power Point Presentation (PPT) slides and other visual material used during the presentations.

3. Memorabilia/Give-aways: Product samples are generally distributed in product launch seminars. Today, concept of CDs or video-versions of presentation on apendrive with corporate branding as give-aways is also coming into vogue.

3.3.3. 15.3.3.3 Audio-Visual Aids

In the last few years there has been a dramatic change in range of audio-visual aids available to the presenter. As discussed earlier, the multimedia technology is becoming all pervasive, hence yesterday’s audio-visual aids have merged into one solid technology.

4. References and further reading


5. Analytic Generalization: srmo.sagepub.com/view/the-sage-dictionary-of-qualitative-inquiry/n5.xml

6. Generalizability: writing.colostate.edu/guides/page.cfm?pageid=1373


8. Generalizability and Transferability: writing.colostate.edu/guides/guide.cfm?guideid=65

9. What is generalization?: explorable.com/what-is-generalization

10. Generalization in quantitative and qualitative research: Myths and strategies: www.sciencedirect.com/science/article/pii/S0020748910002063


13. Statistical Generalization: srmo.sagepub.com/view/encyc-of-case-study-research/n328.xml

5. Questions for Chapter 15

1. What do you understand by the term presentation? What is the need for presentation of report.

2. Explain the objectives/purposes of presentation of a report.

3. Explain the factors to be kept in mind while presenting a report to (a) technical people (b) laymen.

4. What is presentation skill set? Explain the elements of presentation skill set.

5. What are communication issues?