Cairo University

IT/CS 698

Scientific Research Methods

Lecture 2

Lecture Outline

★ **Essential Reference - 1**
  ❖ **Chapter 1:** BASIC RESEARCH METHODOLOGY

★ **Essential Reference - 2**
  ❖ **Chapter 3:** Reading and Reviewing

What Are Research Objectives?

❖To gain familiarity with a phenomenon or to achieve new insights into it (known as exploratory or formulative research studies).

❖To determine the frequency with which something occurs or with which it is associated with something else (known as diagnostic research studies).

❖To test a hypothesis of a causal relationship between variables (known as hypothesis-testing research studies).

What Are Research Types?

★ **Descriptive vs. Analytical**

★ **Applied vs. Fundamental (Pure)**

★ **Quantitative vs. Qualitative**

★ **Conceptual vs. Experimental (or Empirical)**

Descriptive vs. Analytical

★ **Descriptive Research**

❖ The major purpose is description of the state of affairs as it exists at present.

❖ The researcher has no control over the variables; s/he can only report what has happened or what is happening.

❖ Suitable for social sciences and business and management studies.

❖ Includes surveys of all kinds (including comparative and correlation techniques) and fact-finding enquiries of different factors like frequency of shopping, brand preference of people, most popular media programs etc.

Descriptive vs. Analytical - 2

★ **Analytical Research**

❖Researcher makes a critical evaluation of the material by analyzing facts and information already available.

Applied vs. Fundamental (Pure)

★ **Applied Research**

❖ To find a solution for an pressing immediate practical problem facing a society or an industrial/business organization.

Applied vs. Fundamental (Pure) - 2

★ **Fundamental (Pure) Research**

❖ Mainly concerned with generalizations and concentrates on the formulation of theories that may have a broad base of applications either at present or for future.

❖ "Gathering knowledge for the sake of knowledge" is termed "Pure" or "Basic" or "Fundamental" research.

❖ Examples:

✓ Research concerning some natural phenomenon or related to pure mathematics.

✓ Research studies aimed at studying and making generalizations about human behaviour.

Quantitative vs. Qualitative

★ **Quantitative Research**

❖ Applicable to phenomena that can be expressed in terms of quantity.

★ **Qualitative Research**

❖Concerned with qualitative phenomenon.

❖For instance, when we are interested in investigating the reasons for human behaviour (i.e., why people think or do certain things), therefore Motivation Research is an important type of it.

❖Especially important in the behavioural sciences where the aim is to discover the underlying motives of human behaviour.

Conceptual vs. Experimental (Empirical)

★ **Conceptual Research**

✦Related to some abstract idea(s) or theory.

✦Generally used by philosophers and thinkers to develop new concepts or to reinterpret existing ones.

Conceptual vs. Experimental (Empirical) - 2

★ **Experimental (Empirical) Research**

❖ Relies on experiment or observation alone, often without due regard for system and theory.

❖ Is data-based research, coming up with conclusions which are capable of being verified by observation or experiment.

❖ The researcher must first provide himself with a working hypothesis or guess as to the probable results.

❖ S/He then works to get enough facts (data) to prove or disprove her/is hypothesis.

❖ S/He then sets up experimental designs which s/he thinks will manipulate the persons or the materials concerned so as to bring forth the desired information leading to the hypothesis.

What Are Basic Research Approaches?

1. **Quantitative**

2. **Qualitative**

What Are Basic Research Approaches? - 2

1. **Quantitative Research**

   ❖Involves the generation of data in quantitative form which can be subjected to rigorous quantitative analysis in a formal and rigorous fashion.

   ❖Further sub-classified into **inferential**, **experimental** and **simulation** approaches research.

1. **Quantitative Research**

    ➢ **Inferential Approach**

    ❖ Its purpose is to form a database from which to infer characteristics or relationships of population.

    ❖ This usually means survey research where a sample of population is studied (questioned or observed) to determine its characteristics, and it is then inferred that the population has the same characteristics.

1. **Quantitative Research**

    ➢ **Experimental Approach**

        ❖ It is characterized by much greater control over the research environment and in this case some variables are manipulated to observe their effect on other variables.

1. **Quantitative Research**

➢ **Simulation Approach**

❖ It involves the construction of an artificial environment within which relevant information and data can be generated.

❖ This permits an observation of the dynamic behavior of a system (or its subsystem) under controlled conditions.

❖ Given the values of initial conditions, parameters and exogenous variables, a simulation is run to represent the behavior of the process over time.

❖ Simulation approach can also be useful in building models for understanding future conditions.

2. **Qualitative Research**

❖ Concerned with subjective assessment of attitudes, opinions and behavior.

❖ Research in such a situation is a function of researcher's insights and impressions.

❖ Researcher generates results either in non-quantitative form or in the form which are not subjected to rigorous quantitative analysis.

❖ Generally, the techniques of focus group interviews, projective techniques and depth interviews are used.

❖ Engineering research may not have anything to do with this approach.

Research Methodology vs. Research Methods

★ **Research Methods**

❖ Methods/Techniques that researchers use for/adopt to conduct (carry out) their research.

❖ They can be put into the following three groups:

  ➢ Methods concerned with the collection/ acquisition of data; these methods will be used where the data already available are not sufficient to arrive at the required solution.

  ➢ Mathematical/Statistical techniques used for establishing relationships between the data and the unknowns.

  ➢ Methods to evaluate the accuracy of the results obtained.

❖ Research methods falling in the above stated last two groups are generally taken as the analytical tools of research.

Research Methodology vs. Research Methods - 2

★ **Research Methodology**

❖ A way to systematically solve the research problem.

❖ It may be understood as a science of studying how research is done scientifically.

❖ It is necessary for the researcher to know not only the research methods/techniques (how to apply particular techniques, how to develop certain tests, how to calculate indices as the mean, standard deviation or chi-square, etc.), but also the methodology (to know which of these research methods/techniques are relevant and which are not, what would they mean and indicate and why).

★ **Research Methodology**

❖ It is necessary for the researcher to design his methodology for his problem as the same may differ from problem to problem.

❖ It is clear that research methodology has many dimensions and research methods do constitute a part of the research methodology.

❖ The scope of research methodology is wider than that of research methods because methodology considers the logic behind the methods we use in the context of our research problem/study so that research results are capable of being evaluated either by the researcher himself or by others.

★ **Research Methodology**

❖Methodology answers specifically a host of questions like:

➤ *Why a research study has been undertaken?*

➤ *How the research problem has been defined?*

➤ *In what way and why the hypothesis has been formulated?*

➤ *Why we are using a particular method/technique and why we are not using others?*

➤ *What data have been collected?*

➤ *What particular method has been adopted?*

➤ *Why particular technique of analyzing data has been used?*

➤ *...*

Research Process

1. Finding a Topic and Beginning Research

❖ The characteristics of an ideal topic are:

➢ **The scholar should really enjoy the subject;** s/he wants to spend the next several years with it.

➢ **The subject should be timely;** has active open research problem(s) with potential for future work and employment.

✓ Exposing Yourself to Research
  - ❑ *Make a weekly investigation to listen to research talk or search for technical report in the selected subject.*
  - ❑ *Attend at research seminar, session or conference.*
  - ❑ *Keep a written log of one's technical reading and listening.*
  - ❑ *Add these logs and review them periodically to see if some of the ideas begin to fit together.*
  - ❑ *Ask the canonical questions.*

1. **Finding a Topic and Beginning Research**

   ❖ The characteristics of an ideal topic are:

   ➢ **The subject should be timely;** has active open research problem(s) with potential for future work and employment.

   ✓ Becoming an Active Reader, Listener and Critical

   Whenever reading technical material or listens to a research talk, should ask these <u>canonical questions</u>:

   ❑ *From where did the author seem to draw the ideas?*

   ❑ *What exactly was accomplished by this piece of work?*

   ❑ *How does it seem to relate to other work in the field?*

   ❑ *What would be the reasonable next step to build upon this work?*

   ❑ *What ideas from related fields might be brought to bear upon this subject?*

2. Finding a Research Advisor/Guide

❖ The ideal advisor might have the following traits:

➢ *Has research interests in common with the scholar.*

➢ *Has a national or international reputation among researchers.*

➢ *Has grant support for research.*

➢ *Has an active research group.*

➢ *Has successfully directed students in the past.*

➢ *Has a reputation as a fair and reasonable advisor.*

➢ *Has a high probability of staying at the university.*

➢ *Is someone scholars like and admire.*

3. **Formulating the Research Problem**

❖ The very important steps in the formulation process are:

    I.   Understanding the problem thoroughly.

    II.   Rephrasing the same problem into meaningful terms from an analytical point of view.

4. Extensive Reading and Reviewing The Literature

❖ Reading Aims:

➢ Establishes that your work is indeed novel.

➢ Helps understanding current theories, discoveries, and debates.

➢ Can identify newlines of questioning or investigation.

➢ Should provide alternative perspectives on your work.

✓ Reading will ultimately be summarized in the background or the discussions of related work sections in write-ups (paper, thesis, book, ..etc.).

✓ Reading may be built on a wider literature, but the arguments in an output write-up should be based on knowledge that is from a refereed source that is an accepted document by the research community as knowledge source.

4. Extensive Reading and Reviewing The Literature

❖ Reading Sources:

➢ Examined and refereed papers published in reputable venues.

➢ books that are based on the information presented in refereed theses and books.

- ✓ The literature does not include primary sources such as lab notebooks, responses to a survey, or an experiment outputs.

- ✓ Other literature sources (news articles, science magazines, Wikipedia pages, …etc.) may alert you to the existence of reputable work, but is rarely worth citing.

- ✓ The number of papers that a researcher working on a particular research has to know well is usually small, even though the number the researcher should have read to establish their relevance is large.

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers:

➤ Use obvious search terms to explore the Web.

✓ Sometimes the research in an area is divided across separate communities that have different vocabularies.

➤ Use major search engines that have search tools that are specifically for academic papers.

✓ Today, they are the single most effective method for finding relevant work, because they may index by individual, by institution, and by citation.

➤ Visit the websites of researchers and groups working in the area.

✓ They should give several kinds of links into the wider literature: the names of researchers/co-authors whose work you should investigate, and relevant journals/conferences.

4. Extensive Reading and Reviewing The Literature

- ➤ Follow up the references in promising research papers.
  - ✓ They indicate relevant individuals, conferences, and journals.
- ➤ Browse the recent issues of journals and conferences in the area.
- ➤ Search the publisher-specific digital libraries.
  - ✓ They include publishers such as Wiley, Elsevier and Springer, and professional societies such as the ACM and IEEE.
- ➤ Follow up the relevant conferences.
  - ✓ Each conference website lists its program, that is, the papers to appear in it that grouped by year and/or topic.
- ➤ Consider using the citation indexes.
- ➤ Discuss your work with as many people as possible.
- ❑ May be several versions of the same paper: a preprint in an online archive, a conference version, and a *journal version* (USE THIS).

4. Extensive Reading and Reviewing The Literature

❖ Measure of Good Research:

➢ Good research is systematic.

✓ Structured with specified steps to be taken in a specified sequence in accordance with the well defined set of rules. Systematic characteristic of the research does not rule out creative thinking but it certainly does reject the use of guessing and intuition in arriving. at conclusions.

➢ Good research is logical.

✓ Guided by the rules of logical reasoning (induction and/or deduction). Induction is the process of reasoning from a part to that; whole whereas deduction is the process of reasoning from some premise to a conclusion which follows from that very premise.

4. Extensive Reading and Reviewing The Literature

- Good research is empirical.
  - ✓ Related basically to one or more aspects of a real situation and deals with concrete data that provides a basis for external validity to research results.

- Good research is replicable.
  - ✓ Allows research results to be verified by replicating the study and thereby building a sound basis for decisions.

- Good research is a contribution.
  - ✓ Has two properties: originality and validity.
  - ✓ Originality is the degree to which the ideas presented are significant, new, and interesting.
  - ✓ When evaluating the significance of a contribution, it is helpful to consider its effect, or impact.

4. Extensive Reading and Reviewing The Literature

- ✓ Impact: To judge how much change would follow from the paper being published and widely read.
  - ❑ If the only likely effect is passing interest from a few specialists in the area, the paper is minor. Else if, on the other hand, the likely effect is a widespread change of practice or a flow of interesting new results from other researchers, the paper is indeed groundbreaking.
- ✓ Validity is the degree to which the ideas have been shown to be sound.
  - ❑ Good science requires a demonstration of correctness, in a form that allows verification by other scientists.
  - ❑ Such a demonstration is usually by proof or analysis, modelling, simulation, or experiment, or preferably several of these methods together, and is likely to involve some kind of comparison to existing ideas.

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper:

➢ For each paper, keep a record of the answers to some/all of the following questions:

A. What is the main topic the author said they want to discuss?

❑ Is the topic sufficiently novel/interesting (significant)?

✓ *Title, Abstract, Introduction*

❑ Why did the author claim it was important (Impact)?

✓ *Abstract, Introduction, Conclusion*

▪ Who is affected by its result?

▪ What is the form of its effect?

▪ What is the magnitude of the effect?

The End

Questions?