International Journal of Bridge Engineering (IJBE), Vol. 13, No. 1, (2025), pp. 37-52

SCIENTIFIC RESEARCH METHODOLOGY IN MECHANICAL, ELECTRICAL AND CIVIL OR BRIDGE ENGINEERING

Osama Mohammed Elmardi Suleiman Khayal

Department of Mechanical Engineering, Nile Valley University, Atbara – Sudan
e-mail: osamamm64@gmail.com

ABSTRACT: Engineering (i.e. mechanical, electrical and civil or bridge engineering) unlike science, is concerned not only with knowledge of natural phenomena but also with how knowledge serves the needs and desires of humanity. Variables such as cost, user compatibility, deliverability, safety, and adaptability to different external operating conditions and environments must be taken into account when designing, developing, operationally supporting, and maintaining engineer-created products and services. Therefore, engineering requires the combination of experience, procedures, processes and know-how from multiple fields. In addition, almost all undergraduate research in science and engineering is conducted as part of students' advanced training. The aim of working in industry motivates them to pursue advanced studies, and this will increasingly be the case in the future. For this reason, engineering students' perspectives on research tend to be applied in engineering practice. The main goals of research work are to inform work, gather evidence for theories, and add to the development of expertise in the field of study.

KEYWORDS: Objectives; Descriptive and analytical; Applied and fundamental; Quantitative and qualitative; Conceptual and empirical research; Writing reports; Fundamental examples in mechanical, electrical and civil or bridge engineering.

1 INTRODUCTION

Hudson Maxim says that questioning breeds progress and that doubt and uncertainty are better than overconfidence because it leads to questioning, which in turn leads to initiative and invention. Need leads to questioning, and questioning leads to curiosity, which in turn leads to initiative and invention, these definitions coincide with the famous proverb which states "Necessity is the mother of invention".

Research is the pursuit of new knowledge through the process of discovery. Scientific research involves diligent inquiry and systematic observation of

phenomena. Most scientific research projects involve experimentation, often requiring testing the effect of changing conditions on the results. The conditions under which specific observations are made must be carefully controlled, and records must be meticulously maintained. This ensures that observations and results can be are reproduced. Scientific research can be basic (fundamental) or applied.

The objective of basic research is to gain more comprehensive knowledge or understanding of the subject under study, without specific applications in mind. In industry, basic research is defined as research that advances scientific knowledge but does not have specific immediate commercial objectives, although it may be in fields of present or potential commercial interest.

Applied research is aimed at gaining knowledge or understanding to determine the means by which a specific, recognized need may be met. In industry, applied research includes investigations oriented to discovering new scientific knowledge that has specific commercial objectives with respect to products, processes, or services [1] – [18].

2 RESEARCH DEFINITIONS

Scientific research is the pursuit of truth or the search for truth with the help of studies, observations, comparisons and conducting tests. The search for knowledge through organized goals and methods to find solutions to a problem is scientific research.

The organized approach that is concerned with generalization and formulating theories is also scientific research. The method used will vary according to the broad classification of fields of knowledge in terms of historical reviews, language, arts, social sciences, sciences and engineering [19] – [23].

3 OBJECTIVES AND MOTIVATIONS IN RESEARCH [19]–[23]

3.1 Objectives of scientific research

(1) Gaining familiarity with a phenomenon or developing new ideas with this phenomenon. This is called investigative or formative scientific research studies.
(2) Determine the frequency with which something occurs or is combined with something else. This is called diagnostic research studies.
(3) Testing the hypothesis of a causal relationship between variables. This is called hypothetical-test research studies.

3.2 The possible motivations for doing research

(1) The ambition to obtain a research degree in addition to its benefit for a professional career.
(2) Challenge issues or dilemmas that have not been resolved before.

(3) The desire to obtain intellectual joy and self-satisfaction by doing innovative work.
(4) Doing research to serve the community.
(5) Search for fame and respect.
(6) Other motives: Many unmentioned factors, such as state trends, conditions of service, curiosity about new things, social thinking and awareness, can be motivation for writing research.

4 DISTINCT APPROACHES AND SIGNIFICANCE OF RESEARCH

4.1 Descriptive research and analytical research

Descriptive research includes field surveys and finding various types of facts (such as technical and economic feasibility studies for engineering projects, and historical reviews). The primary purpose of descriptive research is to describe the situation as it exists in the present. This method is suitable for social sciences, business studies and management. The basic characteristic of this method is that the researcher cannot control the variables, it only records the events. A common example of this method is studying factors such as shopping frequency, consumer preferences for a particular brand of goods, popular media programs, etc. Survey methods of all kinds fall under descriptive research, including comparison and correlation techniques.

In analytical research, on the other hand, the researcher makes a critical evaluation of the material by analyzing previously available facts and information.

4.2 Applied research and fundamental research

Applied research is finding a solution to an immediate problem facing society or the industrial or business system, while basic research or pure research is concerned with generalization and focuses on formulating theories.

Research in which knowledge is accumulated for the sake of knowledge is known as basic or pure research. Examples of basic research include: research concerned with natural phenomena or related to pure mathematics, and research studies studying human behavior.

While applied research focuses on discovering a solution to some pressing practical problems, basic research revolves around formulating theories that have a broad base of applications at the present time or in the future.

4.3 Quantitative and qualitative research

While quantitative research is applicable to phenomena that can be expressed in terms of quantities, qualitative research is concerned with qualitative phenomena. For example, when we want to investigate the causes of human behavior (why a person thinks or why he behaves in a certain way). We often talk about motivational research which is an important type of qualitative

research. Quantitative research is very important in behavioral sciences when the goal is to discover the hidden motives of human behavior.

4.4 Intellectual (or conceptual) and experimental (or empirical) research

Intellectual research is related to abstract ideas or theories. It is generally used by philosophers and thinkers to develop new concepts or to re-change existing ideas. On the other hand, laboratory research relies solely on tests and observations, without the slightest consideration of system and theory. It is a research based on a database and arrives at conclusions that can be proven by observation and testing. In such research, it is necessary to access the facts from the beginning, from their sources. In such research, the researcher must work on a hypothesis or include possible outcomes. Therefore, he works to obtain sufficient facts or data to prove or disprove a hypothesis. He then creates laboratory designs that he believes subtly manipulate the people or materials of interest.

Experimental research is appropriate when it is intended to prove that certain variables affect other variables.

4.5 How to approach research

From the above discussions it is clear that there are two basic research methods namely quantitative method and qualitative method. The first involves generating data in a quantitative form whereby it is subjected to formal and rigorous quantitative analysis. This method can be further classified into deductive, laboratory and simulation research methods. The purpose of the deductive method in research is to create a database from which characteristics or relationships of a population can be inferred. This usually means survey research in which a sample of the population is studied (by question or observation) to determine its characteristics. Laboratory research is characterized by greater control over the research environment, and in this case some variables are manipulated to observe their effect on other variables.

The simulation method involves creating an artificial environment from which data is generated. This allows viewing the dynamic behavior of a system under controlled conditions. Knowing the values of the initial conditions, variable quantities, and external variables, simulations can be performed to represent the behavior of the process during a certain period of time. The simulation method is useful in building models to know future conditions.

The qualitative method of research is concerned with the objective evaluation of behavior and thoughts. Research in such a situation is a function of the ideas and impressions of the researcher. This method of research generates results either in a non-quantitative form or in a form that is not subjected to rigorous and precise quantitative analysis. In general, group

sampling techniques, projection techniques, and depth sampling techniques can be used. Engineering research may not use this method.

4.6 The significance of research

The following points are important in determining the importance of scientific research:

(1) For students who want to write master's and doctoral research, research means professionalism or a way to reach a distinguished position in the societal structure.
(2) For professionals in research methodology, research means a source of livelihood and earning a living.
(3) For philosophers and thinkers, research means a way out of new ideas.
(4) For intellectuals, men and women, research means developing new methods and innovative works [19] – [23].

5 RESEARCH METHODOLOGY VERSUS RESEARCH METHODS

Research methods are those methods or techniques used in writing research. Therefore, research methods or techniques refer to the methods that researchers adopt to carry out their research.

Research methods can be placed into the following three groups:

(1) The first group contains methods interested in collecting and owning data. These methods will be used when the previously available data is not sufficient to reach the desired solution.
(2) The second group consists of those mathematical and statistical techniques used to establish relationships between data and unknowns.
3) The third group consists of those methods used to evaluate the accuracy of the results obtained.

Research methodology has many dimensions and research methods are part of the research methodology. Research methodology is broader than those methods used in research. In research methodology, the logic is considered according to which the appropriate research method is chosen, why this method or technique is used, why no other method is used, how the research problem is defined, in what way and why the hypothesis is formulated, what data is collected and what is the particular method that is adopted, and why a particular technique is used to analyze the data [19] – [23].

6 RESEARCH PROCEDURES OR STEPS

6.1 Finding a research advisor and/or a guide

Choosing a supervisor is a very important matter directed by the researcher.

6.1.1 Ideal qualities of a potential research advisor and/or a guide

The supervisor must have the following qualities:

(1) He has a common research desire with the researcher.
(2) He has a national and international reputation among researchers.
(3) The research can be supported by a financial or other grant.
(4) He has successfully supervised many students previously.
(5) Has a reputation as a fair and reasonable supervisor.
(6) The possibility of settling and staying at the university is high.
(7) Popular with the researcher.
(8) He has an active research group.

6.1.2 How to find an advisor and/or a guide

Before the researcher enters the university, he must be ensured that the faculty members of the relevant college are active in the researcher's preferred research fields.

Using annual reports of various departments, science scholar citation guides, historical reviews of mathematics, or electronic sources will help the researcher find recent publications from which he can choose the appropriate supervisor. Enlisting the help of students or other researchers to help choose the appropriate supervisor.

The researcher must get to know highly potential supervisors by taking courses with them, or by meeting them in their offices to talk about their favorite research. The researcher must ask about scientific papers related to the research in order to read them. The researcher must receive advice and consultation from the faculty members of the relevant college for whom he maintains respect or from the alumni office.

Good indicators are excellent publications in peer-reviewed journals with excellent ratings, targeted support, and a good teaching record.

6.1.3 The relationship between the supervisor and the researcher

It is important for the supervisor and researcher to develop a harmonious working model. Some supervisors hold weekly group meetings during which the student discusses the tasks he has accomplished and the progress in the research, and other students comment and discussions.

Some supervisors rely on chance meetings inside the hall. Some supervisors expect students to attend seminars, lectures, or workshops to keep up to date with current research findings. If the student feels stuck in continuing his research, he should request additional meetings with the supervisor, or he can seek the help of a faculty member at the college to clarify what he is confused about. As in all relationships, conflicts must be confronted and discussed. Cultural and age differences (generational separation) can lead to misunderstanding between the supervisor and the researcher. In rare cases, the relationship between the supervisor and the researcher worsens. In such cases, the student must look for another supervisor.

6.2 Finding a topic and beginning research

The topic must be current. The previous basic topics will help solve the research problem. You must choose a topic that contributes to solving the problem now and in the future. The researcher's work should lead to a well-defined set of results.

On the other hand, it is impossible to work in a vacuum, and the researcher's task becomes very difficult if he does not work with a group that has similar problems or is close to the topic of his research, where he can share ideas and interact with them. The best research usually shows a high level of creativity and innovation and is usually predictable. The researcher must enjoy the research topic and be willing to spend many years to accomplish it.

6.2.1 How to get research ideas

How to become an Active Reader and Listener.
It is very important to move from the passive style of learning encouraged by traditional lectures to an active and critical learning style. The Researcher must Answer the Following Questions:
Where did the author or researcher get these ideas from?
What exactly part of this research has been completed?
How does the research compare to other work in the same field?
What is a reasonable next step to complete construction of this work?
What ideas can be used in similar areas of research?

6.2.2 Exposing yourself to research

Go to the library weekly to read at least research summaries from magazines and periodicals in the same field as yours. You can choose at least two topics to read in depth and critique.

The researcher must search weekly for technical reports in his field using electronic sources or libraries to choose the appropriate ones. The researcher must attend research seminars or workshops to listen and criticize.

6.2.3 Directed study

Whichever comes first, the research supervisor or the research subject. After choosing the appropriate supervisor and discussing various topics with him, the research topic can be chosen. Or the researcher can choose the topic of his research and then search for a suitable supervisor in the same field of research.

6.2.4 Formulating the research problem: develop the nucleus of an idea

There are two types of research problems: problems related to states of nature and those related to relationships between variables. In the first stage, the researcher must choose the problem he wants to study. For example, he must

determine the general field he desires or the issue he wishes to question. First, the issue can be clarified in a broad, general way, and then ambiguity can be removed by solving some issues related to the problem. Afterwards, a feasibility study is conducted for the solution before formulating the problem.

Formulating a general topic in the form of a specific research problem constitutes the first step in scientific inquiry. Understanding the issue in a precise manner and rephrasing it in meaningful terms from an analytical point of view are considered important steps in the process of formulating the research.

The best way to understand the problem is to discuss it with colleagues or with people who have experience in the field. In academic institutions, the researcher can seek the help of a supervisor or guide who has sufficient experience in various research problems.

Once a researcher identifies a topic that seems worthwhile, he must be sure that historical reviews of the field are available. The researcher must continue reading, listening, and knowing the differences between his research and the research of others. The researcher must constantly update historical reviews.

The researcher can review two types of historical reviews. Intellectual reviews (concepts) concerned with concepts and theories, and empirical reviews linked to similar previous studies. The primary takeaway from this review is to find out what data and other materials are available.

6.3 Extensive literature survey: a trap to avoid

It is possible to spend almost all the time on historical reviews and seminars. The truth of the matter is that there is no benefit to this unless the researcher is an active reader and listener, and unless the researcher devotes his time to developing his ideas as well. It is impossible to finish historical reviews and then begin research. New historical reviews always appear, and as the researcher deepens and expands his research, he will see new areas related to his research that must be studied. Therefore, there must be a balance between historical reviews and the body of the research, as they can be completed in parallel throughout the period of writing the research.

Once the problem is formulated, a brief summary of it should be written. It is obligatory for a researcher writing a doctoral research paper to write a summary of the topic and submit it to the doctoral committee or research council for approval. At this juncture, the researcher must conduct an extensive survey of historical reviews related to the problem. For this purpose, one must refer to scientific papers from peer-reviewed scientific journals, books, and published periodicals. In this process, it must be remembered that one source leads to another source, and so on. Previous studies similar to the current study should be carefully studied.

6.4 Choosing research idea

From reading, interacting with a supervisor during independent study or working on research some possible projects will emerge. The researcher must make a list of possible problems and projects he desires and discuss them with qualified supervisors.

6.5 Stay active

Even after the researcher has decided on his first topic, it is important for the researcher to continue the routine of reading new journals, technical reports, and attending seminars. All of these sources can contribute to developing the researcher's ideas.

At this stage, the researcher can add one question to the list of basic headings: How can these ideas help the researcher solve the research problem? The researcher must remember that the initial idea is usually very far from the final research topic. If the researcher remains active in reading and listening, it will be very easy to generate new topics at the right time [19] – [23].

7 MEASURE OF GOOD RESEARCH

Whatever the types of research and studies, they converge on the common basis of the scientific research used. Scientific research fulfills the following provisions:

The purpose of the research must be clearly defined and common concepts used. The research procedures used should be described in sufficient detail to allow another researcher to repeat the research more widely.

The procedural design of research must be carefully planned to generate results that are fairly consistent with the research objectives. The researcher must talk frankly about the flaws in the procedural design and evaluate their effects on the results obtained.

Data analysis must be sufficient to reveal its importance and the analysis methods used must be appropriate. The validity and reliability of the data must be carefully examined. The conclusion should be limited to those that are justified by the research data and limited to those in which the data give an adequate basis.

Greater confidence in the research is ensured if the researcher has reasonable experience, has a good reputation in the research or is an honest person. In other words, the types of good research can be explained as follows:

Good research is structured: this means that it is structured through specific steps taken in a specific order according to a well-defined set of judgments. The systematic features of research do not exclude creative thinking, but they certainly reject the use of guesswork and intuition in arriving at research conclusions.

Good research is logical: This requires that the research be guided by rational

logical judgments and that the logical procedure for research and conclusion is of high value in carrying out the research.

Good research is experimental: This requires that the research be primarily related to one or more aspects of real situations and deal with solid data that provides a basis for verifying the research results.

Good research is replicable: This feature allows research results to be verified by repeating the study and thus building a good basis for making decisions [19] – [23].

8 COMMON PROBLEMS FOR RESEARCH SCHOLARS IN ENGINEERING

Researchers in the field of engineering face many problems, some of which can be summarized as follows:

(1) The lack of scientific training in research methodology constitutes a major obstacle for researchers around the world.
(2) There is insufficient interaction between the university's research departments on this side and the industrial institutions and research institutions on the other side.
(3) Most industrial units do not have confidence that the materials supplied to the researcher will be put to good use and are therefore often unwilling to supply the necessary information to researchers.
(4) In the case of research studies that overlap with each other, it is necessary to provide sufficient information to compare between them.
(5) There is difficulty in providing timely availability of published research data from government offices or from other agencies specialized in this field of research [19] – [23].

9 INSTRUCTIONS FOR WRITING GRADUATION PROJECTS AND THE GENERAL FORMAT OF THE REPORT

9.1 Instructions for writing graduation projects

9.1.1 Content or research problem

It must be ensured that the project discusses an engineering issue with an administrative aspect. The goals of the project must be clear, even if they are not stated. The project should have its objectives defined in some way in the project report.

At the bachelor's level, the goals must come with something new (an addition to knowledge). The new thing may be applying a theory to solve an engineering problem or solving an engineering problem that has not been solved before, or even if the student describes an engineering problem (a problem in an engineering institution) in an analytical manner and no one before him has done so. By trying to solve it, it can be accepted.

The introduction is to present your project in a sequential and logical manner

and lead the reader from general knowledge of the topic to highlighting your problem. The introduction ends with the goals that the research will achieve in the end. The introduction can be placed in the first chapter or outside the chapters with the abstract if it is short [19] – [23].

9.1.2 Theoretical research

The report must contain theoretical research that proves the theories that the student relied on in solving the problem.

The reference of all theories must be determined. Or, if there is no clear reference, the student can mention the commonly accepted theories in solving this type of problem, but he must determine the possibility of the theory and the extent of its application to the issue under research.

The student must discuss in his research the solutions that were presented to the problem before and the extent of their success. If there are no solutions presented in the problem (i.e. he is the first researcher on the topic), the student must do theoretical research on similar or similar issues and how they were solved and what are his criticisms and comments on these solutions.

In general, theoretical research determines the level of knowledge that can be used to solve the issue under research, as well as where the issue under research is located on the map of research conducted in the same field.

9.1.3 Data collection

There must be a specific method that the student follows in the process of collecting data, and he must explain why he used this method and not another.

It is best for the student to study more than one method, then choose one and explain the reasons for his choice.

Collecting data or following a method to design or conduct an experiment in a specific way and then collecting the results in the form of tables, graphs, photographs etc. The research must contain analysis and conclusions of the results and it must be in a separate section.

9.1.4 Conclusions of the report

There must be a clear summary of the research that explains what the research has achieved (that is, the results reached must be within the objectives of the research and to what extent it succeeded in doing so). There must be a brief self-criticism of the research and an explanation of what is best as part of the conclusions and recommendations.

9.1.5 General structure of the report

The general structure of the research must be in accordance with the general guidelines stipulated below.

9.2 General instructions for the format of the final project

9.2.1 General arrangement of the report

Title page.
Dedication (if any).
Acknowledgments (if any).
Table of contents.
Index of shapes and drawings (if available).
Index of tables (if available).
Report summary (Abstract): Its purpose is to inform the reader of the report about what was covered in the report and the most important results obtained.
The body of the report: It consists of a number of chapters (the first chapter, with its title, the second chapter, with the corresponding title, until the last chapter with its title, then the conclusions and recommendations) after agreement with the supervisor.
References.
Appendices (if any).

9.2.2 Page numbering of the report (pagination)

The title page does not have a number. The pages from the dedication to the summary of the report are numbered in Greek numerals, keeping the number (i) for the first page. That is, the numbering begins with the number (ii), then the number (iii), then (iv), then (v), and so on.

From the beginning of the first chapter, the numbering starts from the number 1, then 2, and so on. (Arabic numbers are used, not Hindi). Numbering in Greek numerals should be put at the bottom of the page in the middle. Numbering in Arabic numerals should be put at the bottom of the page in the middle or in the upper left corner of the page.

9.2.3 Writing report chapters

The research is divided into a number of chapters according to agreement with the supervisor, but the first chapter must contain the introduction or historical origins, and the last chapter must contain the conclusions and recommendations. The titles within the chapters are numbered in Arabic numerals, and the numbers are written in decimal form, up to four places only.
Example of how to number the first chapter:

Chapter One
Introduction

1.1 An Overview of the Importance of Steel in Bridge Engineering Industry
1.1.1 Carbon Steel
1.1.1.1 Low Carbon Steel
1.1.1.2 Medium Carbon Steel
1.1.1.3 High Carbon Steel

If the numbering exceeds four places, the letters A, B, C... etc. can be used. The first number indicates the order of the chapter within the research, and the second number indicates the order of the paragraph within the research.

All tables and drawings must have titles. The title of the drawing is written below the drawing, given a number, and referred to in the body of the research. The title of the table is written at the top of the table, given a number, and also referred to in the body of the research. The numbers of tables and drawings are mostly composed of two decimal numbers, the first meaning the chapter number and the second meaning the number of the table or drawing within the chapter.

9.2.4 Writing format

When writing in Arabic, the following must be taken into account:
Black ink printing (computer printing preferred). Printing on white (A4) paper.
No colored papers or decorations are accepted except colored photographs or graphs whose colors have meaning in the report.
Printing on A4 sheet has the margins as follows:
At least 1.5 cm from the left. At least 3.5 cm from the right. At least 2 cm from the top of the page. At least 2 cm from the bottom of the page.
Or 2 cm from all four sides of the paper. Normal font size (14), preferably Simplified Arabic or Calibri. It is recommended that the distance between one line and the next line be from 1 to 1.5.
Titles can be in regular font or font up to Simplified Arabic or Calibri (18).
Regarding font size, you can follow the following instructions:
Use font size 16 and bold when writing the chapter and the chapter title at the top of the page. Use font size 14 and bold when writing side headings or subtitles. Use a normal font size of 14 when writing the remainder research body.

9.2.5 References or bibliographies

The reference must be written, and students must choose an appropriate method for writing the reference according to what is followed in books, scientific journals, references, reports, etc.
It is written in the following form in the case of books: Name of the author - year - title of the book - edition - house and place of publication
It is written as follows in the case of periodicals: Author name - year - subject title - periodical name - volume - issue - date - page numbers.
Printing must be on one side of the paper. The graduation project must be free of decorations. Appendices are at the end of the graduation project and are numbered in Arabic letters or Greek numerals.

9.2.6 Title page

The title page should contain the following from top to bottom:
University name. (font size 20 – 24).
College name. (font size 20 – 22).
The relevant department (i.e. Department of Manufacturing Engineering, Mechanical Engineering, Electrical and Electronic Engineering, Civil Engineering...etc. (font size 20)).
Title of the report or research. (Font size 18).
A graduation project as a supplementary requirement to obtain a Bachelor of Honors degree in Mechanical Engineering, Manufacturing Engineering, Electrical and Electronic Engineering, Civil Engineering...etc. (Font size 18).
The student or students who prepared the research (name in full). (font size 16).
Supervising Professor (full name). (font size 16).
Date of Submission (i.e. September 2024). (font size 16).

Example of a Typical Title Page:

Nile Valley University
College of Engineering and Technology
Department of Mechanical Engineering

Performance of Rickshaw Vehicles in Sudan
(THE PERFORMANCE OF RICKSHAW VEHICLES IN SUDAN)

A Graduation Project as a Supplementary Requirement for Obtaining a Bachelor of Honors Degree in Mechanical Engineering

Students
1. Rayan Salah al-Din Abbas Abdel Majeed
2. Lamia Abdullah Ali Fazzari
3. Ali Muhammad Ali Hamad Al-Nil

Supervising Professor
Dr. Osama Muhammad Al-Mardi Suleiman Khayal
September 2024

10 CONCLUSIONS

Here is a summary of some of the many reasons why research in both engineering (i.e. mechanical, electrical and civil or bridge engineering) and science is important for everyone, not just students and scientists:

(1) Knowing why research is important seems obvious, but many people avoid it like the plague. However, for those who enjoy learning, whether they are members of a research institute or not, doing research is not only important, but essential.
(2) It is a tool for developing knowledge and facilitating learning. Research is required not only for scholars and academics but likewise for all professionals and non-professionals. It is equally important for aspiring and seasoned engineers.

(3) For ordinary people who value learning, doing research provides them with basic awareness about the universe and the abilities that help them survive and improve their lives. On the other hand, when it comes to research professionals themselves, finding something interesting to discuss and/or write about should go beyond just personal experience. Identifying what the general public might want to know or what researchers want others to achieve or envision can be a good reason to undertake research work. Therefore, research is an essential element in knowledge production and vice versa.

(4) Knowledge is generally described as a factual assumption in the mind of an individual. It basically refers to facts based on objective information and/or results of studies processed by the human brain. It can be obtained in various ways including reading books and articles, listening to experts, watching documentaries or investigative programs, conducting scientific experiments, interacting with others, talking to people, etc. Facts collected during research can be verified and compared with other sources to ensure their truthfulness and accuracy. Three types of knowledge have been identified, namely procedural (skill or know-how), acquaintance (familiarity), and propositional (description of a fact or situation).

REFERENCES

[1] Krishnan Nallaperumal, Engineering Research Methodology, a Computer Science and Engineering and Information and Communication Technologies Perspective, First Edition.

[2] Roel Wieringa, University of Twente, the Netherlands, 2008.

[3] Kaur, Gurinder. "Research Methodology and Statistical Analysis." International Journal of Science and Research (IJSR) 13, no. 7 (July 5, 2024): 586–89. http://dx.doi.org/10.21275/sr24710133153.

[4] VENKATESWARLU, KASETTI. "Management Methodology for Research Projects." Global Journal for Research Analysis 3, no. 6 (June 15, 2012): 130–31. http://dx.doi.org/10.15373/22778160/june2014/44.

[5] Glick, David B. "Research Methodology." Anesthesia & Analgesia 124, no. 5 (May 2017): 1727. http://dx.doi.org/10.1213/ane.0000000000001977.

[6] Schwarcz-Besson, Priscille. "The Field in Psychoanalytic Research Methodology." Thesis, Pacifica Graduate Institute, 2017. http://pqdtopen.proquest.com/#viewpdf?dispub=10636888.

[7] Fredrick, Emma G., Abbey K. Mann, Sheri L. LaDuke, Kathleen A. Klik, and Stacey L. Williams. "Methodology in Sexual Minority Stigma Research." Digital Commons @ East Tennessee State University, 2015. https://dc.etsu.edu/etsu-works/8078.

[8] Miller, Michael Chad. "Global Resource Management of Response Surface Methodology." PDXScholar, 2014. https://pdxscholar.library.pdx.edu/open_access_etds/1621.

[9] Aityan, Sergey K. Business Research Methodology. Cham: Springer International Publishing, 2022. http://dx.doi.org/10.1007/978-3-030-76857-7.

[10] Deb, Dipankar, Rajeeb Dey, and Valentina E. Balas. Engineering Research Methodology. Singapore: Springer Singapore, 2019. http://dx.doi.org/10.1007/978-981-13-2947-0.

[11] De Sordi, José Osvaldo. Design Science Research Methodology. Cham: Springer International Publishing, 2021. http://dx.doi.org/10.1007/978-3-030-82156-2.

[12] Eisend, Martin, and Alfred Kuss. Research Methodology in Marketing. Cham: Springer International Publishing, 2019. http://dx.doi.org/10.1007/978-3-030-10794-9.

[13] Dubey, Umesh Kumar Bhayyalal, and D. P. Kothari. "Research Reports." In Research Methodology, 251 – 64. Boca Raton: Chapman and Hall/CRC, 2022. http://dx.doi.org/10.1201/9781315167138-17.
[14] Torres, Marta, João Correia de Freitas, and Mônica Mesquita. "RESEARCH METHODOLOGY. FOR WHOM?" In 13th International Conference on Education and New Learning Technologies. IATED, 2021. http://dx.doi.org/10.21125/edulearn.2021.1390.
[15] Soroka, T. V. "METHODOLOGY OF MODERN COGNITIVE STUDIES: THEORETICAL FOUNDATIONS OF RESEARCH." In MODERN PHILOLOGY: THEORY, HISTORY, METHODOLOGY. PART 1. Baltija Publishing, 2024. http://dx.doi.org/10.30525/978-9934-26-425-2-9.
[16] Viamonte, Ana Júlia, Isabel P. Figueiredo, and Isabel M. Pinto. "TRADITIONAL METHODOLOGY AND TBL METHODOLOGY IN MATHEMATICS TEACHING." In 16th annual International Conference of Education, Research and Innovation. IATED, 2023. http://dx.doi.org/10.21125/iceri.2023.1214.
[17] Kokurina, Olga Yu, and Alexander S. Burov. METHODOLOGY OF EMPIRICAL RESEARCH OF SOCIAL RESPONSIBILITY AND VALUE ORIENTATIONS OF STUDENTS. SIB-Expertise, December 2023. http://dx.doi.org/10.12731/er0757.18122023.
[18] Coleman, Justin Leigh. RISMC Toolkit and Methodology Research and Development Plan for External Hazards Analysis. Office of Scientific and Technical Information (OSTI), March 2016. http://dx.doi.org/10.2172/1406973.
[19] Professor Mahmoud Yassin Osman, Mechanical Engineering Department, Faculty of Engineering and Technology, Nile Valley University, General Instruction of Writing Theses, 2000.
[20] Professor Mohammed Ibrahim Shukri, Production Engineering Department, Faculty of Engineering and Technology, Nile Valley University, How to Write a Research, 2002.
[21] Associate Professor Osama Mohammed Elmardi Suleiman Khayal, Mechanical Engineering Department, Faculty of Engineering and Technology, Nile Valley University, Methodology of Scientific Research, 2021.
[22] Associate Professor Osama Mohammed Elmardi Suleiman Khayal, Mechanical Engineering Department, Faculty of Engineering and Technology, Nile Valley University, Scientific and engineering miracles in the Qur'an, Noor Library, 2018.
[23] Associate Professor Osama Mohammed Elmardi Suleiman Khayal, Scientific research methodology book - Engineering research methodology, ISBN: 978-620-3-85883-9, Editor: V. Ibrahim, Status: Published.