Research Methodology in Engineering: A Descriptive Study

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Abstract
Studying research methodology in engineering aims to cultivate essential skills such as critical thinking, problem-solving, ethical practices, and effective communication, which are crucial for engineers to conduct impactful research and drive innovation in response to societal challenges. Unlike pure sciences, engineering emphasizes applying knowledge to meet human needs, considering factors like cost, usability, safety, and adaptability in product design and maintenance. This discipline integrates experiences and techniques from various fields, with undergraduate research serving as a foundation for students' advanced training, often motivated by industrial applications. Ultimately, the primary goals of research in engineering are to support practical work, substantiate theoretical frameworks, and contribute to the expertise in the field.
Keywords: Motivation; Objectives; Descriptive; Analytical; Conceptual; Empirical Research; Writing Reports; Plagiarism.

1. Introduction

Studying research methodology in engineering is essential for developing the skills needed to effectively approach problems and conduct investigations. The main objectives include: Familiarity with different research designs helps engineers select the right approach for their projects; It equips engineers with systematic skills to frame questions and hypothesize solutions, enabling them to tackle complex issues; Engineers learn to collect and analyze data using statistical methods, ensuring informed decision-making; and The study encourages evaluation of existing literature and methodologies, enhancing the ability to critically analyze findings; Engaging with research methodologies aids in identifying knowledge gaps and exploring new technological solutions; Engineers learn to design credible studies that minimize bias and uphold ethical standards; Training in effective communication allows engineers to present and share their research findings broadly; It enables the translation of theoretical knowledge into practical solutions that address societal needs; and A strong foundation in research methodology helps engineers identify future opportunities and trends.

In summary, studying research methodology is vital for engineers as it fosters scientific inquiry, enhances problem-solving abilities, and prepares them to contribute ethically and effectively to advancements in engineering and technology.

Hudson Maxim asserts that questioning fosters progress, arguing that doubt and uncertainty are preferable to overconfidence because they encourage inquiry, which leads to initiative and innovation. He suggests that necessity drives questioning, which in turn sparks curiosity, ultimately resulting in initiative and invention. This concept aligns with the well-known adage, "Necessity is the mother of invention".

Research is the quest for new knowledge through discovery. Scientific research encompasses thorough inquiries and systematic observations of phenomena. Most scientific studies involve experimentation, often necessitating tests to observe how changes in conditions affect results. It is essential to control the circumstances under which observations occur and to maintain meticulous records to ensure reproducibility of the results. Scientific research can be categorized as either basic (fundamental) or applied.

The goal of basic research is to acquire a deeper understanding of a subject without having specific applications in mind. In the context of industry, basic research advances scientific knowledge without immediate commercial objectives, even if it pertains to fields with current or potential commercial relevance. Conversely, applied research focuses on obtaining knowledge or understanding to address a specific, recognized need. In industry, applied research entails investigations aimed at uncovering new scientific knowledge that aligns with specific commercial goals concerning products, processes, or services [1], [2], [3], [4], and [5].

2. Historical Background

The inception of English scientific writing can be traced back to the 14th century, marking a pivotal moment in the development of a structured method for documenting and disseminating scientific ideas. This nascent form of writing laid the groundwork for what would evolve into a more formalized approach to scientific discourse. A significant milestone occurred in 1665 with the founding of the first English scientific journal, the Philosophical Transactions of the Royal Society, by the notable scientist and editor Henry Oldenburg. This publication is widely recognized not only for its historical significance but also for its role in establishing the cornerstone principles that govern scientific journals today.

The Philosophical Transactions introduced and emphasized the concept of scientific priority, which pertains to the recognition of original research and the importance of publishing findings first. This aspect is crucial in the scientific community, where being the first to report a discovery can have lasting implications on an individual researcher's career and the direction of future studies. Additionally, the journal pioneered the practice of peer review, wherein submitted articles are evaluated by experts in the field before publication. This process enhances the quality and credibility

of scientific work, ensuring that the research published in reputable journals meets certain standards of rigor and validity.

Modern practices for standardized citation and referencing systems, which are now fundamental in academic writing, did not emerge until the 20th century. The introduction of the Chicago Manual of Style marked a significant advance in codifying citation formats, providing authors with a systematic way to acknowledge sources and give credit to prior work. This was followed by the emergence of the American Psychological Association (APA) citation style in 1929, which has since gained immense popularity and is widely regarded as one of the most used citation formats across various disciplines, particularly in the social sciences.

The Royal Society has been instrumental in establishing good practices for scientific writing. One of its founder members, Thomas Sprat, emphasized the importance of clarity and straightforwardness in scientific communication. In his seminal work, History of the Royal Society of London, he advocated for a plain and accurate style of writing, eschewing ornate rhetoric that could obscure meaning. Alongside him, prominent scientists like Robert Boyle stressed the need to engage readers without resorting to a dull or lifeless writing style. Their combined focus on effective communication laid a theoretical foundation that persists in modern scientific writing.

In today's globalized academic climate, where the majority of prestigious scientific journals accept manuscripts solely in English, a whole industry has emerged to support non-native English-speaking authors. These services, which include proofreading, editing, and language enhancement, are becoming increasingly accepted as essential tools for improving the quality of scientific manuscripts. This development significantly alleviates the pressure on researchers, allowing them to prioritize their scientific investigations while still ensuring that their work meets the editorial standards required for publication in leading journals.

In addition to traditional editing services, technological advancements have introduced software tools that leverage Natural Language Processing (NLP) to assess and enhance the quality of scientific writing. These innovative tools assist authors by conducting readability tests and providing insights into the structure and clarity of their manuscripts. An example of such a tool is SWAN, a Java application created by researchers at the University of Eastern Finland. By utilizing such technologies, writer-scientists can evaluate their work prior to submission, improving their chances of acceptance and, consequently, the dissemination of their research findings within the scientific community. The confluence of historical developments in scientific writing and contemporary technological advancements signifies a dynamic evolution in how scientific knowledge is communicated and shared [6], [7] and [8].

3. Definitions of Scientific and Engineering Research

Scientific and engineering research are critical domains that deepen our comprehension of the world and foster technological progress.

3.1 Scientific Research

Definition: This refers to a structured exploration of natural phenomena aimed at acquiring new insights or affirming established theories, adhering to the scientific method (which includes observation, hypothesis formation, experimentation, and analysis).

Objective: The primary goal is to broaden knowledge and clarify natural occurrences.

Hypothesis-Driven: It begins with a hypothesis that is tested through experimental methods.

Replicability: Findings must be repeatable to ensure validity.

Peer Review: Research outcomes undergo thorough examination by experts before publication.

Methods: Employs both quantitative and qualitative techniques for analysis.

3.2 Engineering Research

Definition: This field applies scientific principles to the design, construction, and optimization of technologies aimed at addressing practical, real-world issues.

Application-Oriented: It prioritizes solving practical problems and fostering innovation.

Design and Optimization: Involves creating and refining products for efficiency and affordability.

Prototype Development: Encompasses the testing of prototypes in real-world settings.

Interdisciplinary: Combines knowledge from multiple disciplines to create effective solutions.
Feedback Loop: Research continually informs further studies based on practical applications.

3.3 Commonalities and Differences

While both scientific and engineering research aim to advance knowledge and innovation, they differ in their focus: scientific research is exploratory and theory-oriented, whereas engineering research is practical and application-driven. Scientists establish theories that engineers then utilize to develop functional systems.

In combination, scientific and engineering research play vital roles in societal advancement, with scientific research laying the groundwork of knowledge that engineering research translates into practical technologies, addressing significant challenges and enhancing quality of life. Scientific research embodies the pursuit of truth through systematic studies, observations, comparisons, and various tests. It is a methodical quest for knowledge guided by structured objectives and approaches aimed at resolving specific issues. Additionally, it follows an organized framework that seeks to generalize findings and formulate theories. The methods used in scientific research can vary depending on the specific fields of knowledge, including historical analysis, linguistics, the arts, social sciences, natural sciences, and engineering.

Refer to references [9], [10], [11], and [12].

4. Research Objectives and Motivations

4.1 Objectives of Scientific Research

Familiarization and Idea Development: This involves understanding a phenomenon or generating new concepts related to it, referred to as investigative or formative scientific research studies.
Frequency Determination: This objective focuses on measuring how often a certain event occurs or how it interacts with other factors, known as diagnostic research studies.
Hypothesis Testing: This aims to assess the validity of a proposed causal relationship between variables, termed hypothetical-test research studies.

4.2 Potential Motivations for Conducting Research

Pursuit of Academic Credentials: The aspiration to earn a research degree, which can also enhance professional opportunities.
Addressing Unresolved Issues: Tackling problems or dilemmas that have not been previously addressed.
Intellectual Fulfillment: The quest for personal satisfaction and joy that comes from engaging in innovative work.
Community Service: Conducting research with the intention of benefiting society at large.
Seeking Recognition: The pursuit of fame and respect in academic or professional circles.
Additional Motivations: Various other influences can drive research efforts, including societal trends, employment conditions, curiosity about new topics, and increasing social awareness.

Refer to references [13], [14], [15], [16], and [17].

5. Various Research Approaches and Their Importance

5.1 Descriptive and Analytical Research

Descriptive research encompasses field surveys and the collection of diverse data types, such as feasibility studies in engineering and historical analyses. The main goal of descriptive research is to present the current state of affairs, making it particularly valuable in social sciences, business, and management. A key feature of this approach is that the researcher does not manipulate variables but instead documents occurrences as they happen. Common applications include assessing factors like shopping habits, consumer preferences for specific brands, and trending media programs. All survey methods, including comparative and correlational techniques, fall under this umbrella. In contrast, analytical research involves critically evaluating existing data and information to gain insights.

5.2 Applied and Fundamental Research

Applied research seeks to address immediate societal challenges or issues within business and industry, while fundamental research, also known as pure research, focuses on the formulation of theories and broader generalizations. Basic research aims to expand knowledge for its own sake, with examples including studies on natural phenomena, pure mathematics, or human behavior. While applied research targets practical solutions to urgent problems, fundamental research is oriented towards developing theories applicable in the current or future context.

5.3 Quantitative and Qualitative Research

Quantitative research deals with phenomena that can be quantified, whereas qualitative research focuses on qualitative aspects. For instance, when exploring the reasons behind human behavior—such as why individuals think or act a certain way—motivational research serves as a vital form of qualitative investigation. Quantitative methods are crucial in behavioral sciences for uncovering underlying motivations behind actions.

5.4 Intellectual and Experimental Research

Intellectual research pertains to abstract concepts and theories, often employed by philosophers to generate new ideas or revise existing ones. In contrast, experimental research relies entirely on empirical testing and observation, disregarding theoretical frameworks. This approach requires researchers to begin with factual information from original sources and to work with hypotheses, seeking to validate or refute them through rigorous data collection. Experimental research is particularly suitable for investigating the impact of specific variables on others.

5.5 Research Methodologies

The discussion highlights two primary research methods: quantitative and qualitative. The quantitative approach involves the generation of numerical data subjected to rigorous statistical analysis and can be further categorized into deductive, laboratory, and simulation research. Deductive research aims to create a database from which population characteristics can be inferred, often through surveys. Laboratory research allows for greater control over variables and environments to observe their effects. The simulation method creates artificial environments to generate data and observe system behaviors under controlled conditions, proving useful in modeling future scenarios.

Qualitative research, on the other hand, focuses on subjective evaluations of behavior and thought processes, resulting in non-quantitative outcomes. This approach depends significantly on the researcher's insights and impressions and commonly utilizes techniques such as group sampling, projection, and depth sampling, though it may be less prevalent in engineering research.

5.6 Importance of Research

The significance of scientific research is highlighted by several points:

For students undertaking master's or doctoral studies, research signifies professionalism and a pathway to recognition within society.

For professionals specializing in research methodology, it serves as a primary source of income.

For philosophers and thinkers, research is a means to explore and generate innovative ideas.

For intellectuals, it fosters the development of new methods and creative works.

Refer to references [18], [19], [20], and [21].

6. Research Methodology versus Research Methods

Research methods refer to the techniques or procedures employed in the process of conducting research. They encompass the various approaches that researchers utilize to execute their studies. These methods can be categorized into three main groups:

Data Collection Methods: This group includes techniques specifically focused on gathering and managing data, particularly useful when existing data is inadequate for achieving the research objectives.

Analytical Techniques: The second category comprises mathematical and statistical methods that help establish connections between known data and unknown variables.

Evaluation Methods: The third group consists of techniques aimed at assessing the accuracy and reliability of the results obtained.

While research methods are an integral part of the broader concept of research methodology, research methodology encompasses a wider scope. It involves the rationale behind selecting specific research methods, the reasoning for favoring one technique over another, the formulation of the research problem, the development of hypotheses, the types of data collected, the methods employed for data analysis, and the justification for the chosen techniques [22].

7. Research Procedures

7.1 Selecting a Research Advisor

Choosing a supervisor is a critical decision for any researcher.

7.1.1 Ideal Traits of a Potential Research Advisor

A suitable supervisor should possess the following attributes:
Shared research interests with the researcher.
Established national and international recognition within the research community.
Availability of financial or other grant support for the research.
A history of successfully supervising many students.
A reputation for being fair and reasonable.
A strong likelihood of remaining at the university long-term.
Good rapport with the researcher.
An active and engaged research group.

7.1.2 Locating an Advisor

Before enrolling in the university, researchers must ensure that faculty members in their department are active in their areas of interest. They can utilize annual departmental reports, citation databases, historical reviews in relevant fields, or online resources to identify recent publications that may guide their choice of supervisor.

Networking with current students or researchers can also aid in identifying suitable supervisors. Engaging with potential supervisors by attending their classes or arranging meetings to discuss mutual research interests is essential. Researchers should inquire about relevant scientific literature to inform their reading.

Consulting with respected faculty members or utilizing alumni resources is highly beneficial. Look for supervisors with substantial publications in peer-reviewed journals, focused funding support, and commendable teaching records.

7.1.3 The Supervisor/Researcher Relationship

Developing a collaborative working relationship is crucial. Some supervisors organize weekly meetings for progress discussions, while others may rely on informal encounters. Expectations for attending seminars and workshops to stay informed about research advancements are common.

If researchers feel stagnant, they should proactively request additional meetings with their supervisors or seek assistance from other faculty members to address their uncertainties. Open discussions about conflicts and misunderstandings, which can arise from cultural or generational differences, are important for maintaining a healthy relationship. In rare instances of severe discord, it may be necessary for the researcher to seek a new supervisor.

7.2 Identifying a Research Topic and Initiating Research

The chosen topic should be relevant and contemporary, addressing both present and future issues. Previous foundational studies can provide insights to tackle the research problem. Researchers should aim for well-defined outcomes from their work. Working in isolation can hinder progress; therefore, collaboration with peers facing similar research challenges is vital. High levels of creativity and innovation, often present in successful research, should be pursued. A genuine interest in the topic will be crucial for long-term commitment.

7.2.1 Generating Research Ideas

Transitioning from passive to active learning methods is essential. Researchers should critically engage with sources and consider the following questions:
Where did the author derive these ideas?

Which portions of the research are completed?
How does this work compare to similar studies?
What would be a sensible next step in advancing this research?
How might these ideas apply in other related fields?

7.2.2 Engaging with Research

Regular visits to the library to read research summaries from journals in the researcher's field are advisable. At least two topics should be explored in depth for critique. Weekly searches for technical reports in relevant fields, either online or in libraries, will aid in selecting pertinent materials. Attending research seminars or workshops for exposure and critique is also beneficial.

7.2.3 Directed Study

Whether guided by the supervisor or arising from the research topic, decisions on the research direction should be made after discussions. Selecting a topic and then finding a suitable supervisor, or vice versa, can be effective strategies.

7.2.4 Formulating the Research Problem

Research problems can be categorized into those concerning states of nature or relationships between variables. Researchers must first identify the broad issue they intend to explore and gradually clarify the details by addressing related concerns. Following this, a feasibility assessment is essential before articulating the specific research problem.

A clear understanding of the issue and its precise rephrasing in analytical terms are foundational steps in scientific inquiry. Collaborative discussions with colleagues or experienced individuals in the field can enhance this understanding. The researcher should ensure that comprehensive literature reviews exist for the chosen topic, while consistently updating their knowledge on historical analyses.

Researchers should explore two types of reviews: conceptual reviews focusing on theories and empirical reviews connecting to prior studies. This review process is about identifying relevant data and resources available.

7.3 Conducting a Comprehensive Literature Review

It is easy to become overly consumed by literature reviews and seminars, yet this can be counterproductive without active engagement and idea development. Researchers cannot expect to finish all historical reviews before beginning their research, as new relevant studies continuously emerge. Thus, a balance between literature review and conducting research is vital, and both should proceed concurrently throughout the writing process.

Once a research problem is established, a concise summary should be drafted. For doctoral candidates, this summary must be submitted for approval to the doctoral committee or research council. At this stage, an extensive literature survey relevant to the problem at hand must be conducted by consulting peer-reviewed journal articles, books, and published works. Researchers should be aware that one source often leads to additional sources, thus creating a pathway for deeper exploration of similar previous studies.

7.4 Selecting a Research Idea

As researchers engage in reading and collaborating with their supervisors, potential project ideas will naturally emerge. Compiling a list of preferred topics and discussing them with knowledgeable supervisors is a prudent course of action.

7.5 Maintaining Engagement

Even after settling on a research topic, it is essential for researchers to continue reading new journals, technical reports, and participating in seminars. These activities contribute to enriching the researcher's ideas. At this juncture, adding a new question to the foundational headings like how can these ideas assist in solving the research problem.

Remember, the initial concept is often quite different from the final research topic. Remaining active in reading and listening will facilitate the emergence of relevant new topics over time.

Refer to [19].

8. Criteria for Evaluating Quality Research

Regardless of the type of research conducted, all studies share a common foundation rooted in scientific methodology. High-quality scientific research adheres to the following criteria:

Clear Objective: The research purpose must be explicitly defined, utilizing commonly understood concepts.

Detailed Methodology: The procedures employed in the research should be described in enough detail to enable others to replicate the study effectively.

Well-Planned Design: The research design must be meticulously crafted to yield results that align closely with the research goals.

Transparency in Limitations: Researchers should openly discuss any flaws in the design and assess how these imperfections may impact the findings.

Thorough Data Analysis: Data analysis should be comprehensive enough to highlight its significance, employing appropriate analytical methods. The validity and reliability of the data must be rigorously assessed.

Justifiable Conclusions: Conclusions drawn from the research should be strictly based on the data, remaining within the limits of what the data can substantiate.

Researcher Credibility: Confidence in the research increases if the researcher possesses relevant experience, a solid reputation, or demonstrates integrity.

In summary, the characteristics of good research can be outlined as follows:

Structured: Good research follows a structured approach, involving specific steps taken in a defined order guided by established principles. While creativity is encouraged, reliance on guesswork or intuition is not acceptable for reaching conclusions.

Logical: The research process should be governed by rational and logical reasoning, ensuring that the methods and conclusions are coherent and valuable.

Experimental: Quality research is linked to real-world situations and relies on concrete data that serves as a basis for verifying results.

Replicable: Good research must be replicable, allowing for the validation of results through repeated studies, thereby providing a solid foundation for informed decision-making.

Refer to [23].

9. Common Challenges Faced by Engineering Researchers

Researchers in engineering encounter several significant challenges, which can be outlined as follows [24], [25], [26], and [27]:

1. A major hindrance for researchers globally is the insufficient training in research methodology.
2. There is limited collaboration between university research departments and industrial as well as research institutions.
3. Many industrial organizations lack confidence that the materials shared with researchers will be effectively utilized, leading to reluctance in providing essential information.
4. When research studies overlap, it is crucial to offer adequate information for effective comparison.
5. Researchers often struggle with the timely access to published data from government agencies and specialized organizations in the relevant research field.

10. Ethical Considerations

In the development of a methodology, it is essential for researchers to uphold ethical standards to foster trust, accountability, mutual respect, and fairness (Resnik, 2015) [28]. Saunders, Lewis, and Thornhill (2003, p. 131) [29] highlight several ethical aspects that researchers need to consider, particularly during the collection and presentation of research data :

The privacy rights of all individuals involved in the study.

Participation must be voluntary, allowing individuals the freedom to withdraw either partially or fully at any time.

Informed consent must be obtained from all participants before their involvement.

Researchers must ensure the confidentiality of data shared by participants and maintain the anonymity of identifiable individuals.

Researchers should be attentive to how their methods for data collection may impact participants' experiences.

The analysis and presentation of data should be conducted in a manner that considers the potential effects on participants.

Lastly, researchers must maintain their objectivity and ethical conduct throughout the study.

Even in writing a methodology, researchers must adhere to ethical norms to ensure trust, accountability, mutual respect, and fairness [28]. According to Saunders, Lewis, and Thornhill (2003, p. 131) [29], there are some ethical considerations that researchers must be mindful of, especially during the process of gathering and presenting research data:

The rights to privacy of the individuals involved.

The nature of participation in the research must be voluntary and the individuals involved must have the right to withdraw partially or completely from the process.

All participants must provide their consent first.

Maintenance of the confidentiality of data provided by individuals as well as identifiable participants' anonymity.

How participants react to the researchers' methods in seeking to collect data.

How the participants will be affected by the way in which data is analyzed and reported.

The behavior and objectivity of the researcher.

11. Instructions for Writing Graduation Projects and the General Format of the Report

11.1 Instructions for Writing Graduation Projects

11.1.1 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.

11.1.2 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.

11.1.3 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.

11.1.4 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.

11.1.5 General Structure of the Report

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

11.2 General Instructions for the Format of the Final Project

11.2.1 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).

11.2.2 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.

11.2.3 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.

11.2.4 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.

11.2.5 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.

11.2.6 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
Refer to references [1], [30], and [31].

12. Conclusions

The study of research methodology is essential for engineers, as it promotes scientific inquiry, improves problem-solving skills, and equips them to ethically influence advancements in their field. The origins of English scientific writing date back to the 14th century, establishing a structured way to document scientific ideas. A landmark event occurred in 1665 with the launch of the first English scientific journal, Philosophical Transactions of the Royal Society, which introduced key principles like scientific priority and peer review, essential for quality and credibility in research.

Standard citation practices emerged in the 20th century, with the Chicago Manual of Style and the APA citing format becoming widely adopted. The Royal Society contributed significantly to promoting clear scientific communication, emphasizing straightforward language over complex rhetoric.

Today, in a global academic environment where English dominates, services to assist non-native speakers with editing and proofreading are increasingly vital. Technological advancements, such as Natural Language Processing tools like SWAN, further support authors by improving manuscript quality pre-submission .

Research is crucial not only for academics but for all knowledge seekers, including professionals and laypeople. It enhances understanding of the universe and skills necessary for everyday life. Knowledge, characterized as justified belief, can be acquired through various means, and includes procedural, acquaintance, and propositional types. Overall, undertaking research is foundational for knowledge creation and dissemination.

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