Akshaya Institute of Technology., Tumakuru

Department Of Electronics and Communication Engineering

RESEARCH METHODOLOGY & IPR

BRMK557

MODULE-I

Mr. Pradeep kumar V H

B E, M.Tech

Assistant Professor

Dept.. Of E&CE

Module-1

Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research,
Types of Engineering Research,
Finding and Solving a Worthwhile Problem.

Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.

1.1 Meaning of Research

- Research is a derivative of the French word; ‘Researche’ means quest, search, pursuit and search for truth.

- The term ‘Research’ consists of two words. Research = Re + Search. ‘Re’ means again and again and ‘Search’ means to find out something, the following is the process:

- Therefore, research means to observe the phenomena again and again from different dimensions.

DEFINITION OF RESEARCH

- Research in common parlance refers to a search for knowledge.
- The Dictionary meaning of research is “a careful investigation or inquiry especially through search for new facts in any branch of knowledge.”
- Research can also be defined as a scientific and systematic search for pertinent information on a specific topic. In fact, research is an art of scientific investigation.
- The research is defined as a “systematized effort to gain new knowledge- Redman and Mory.
- Some people consider research as a movement, a movement from the known to the unknown.

- The research comprises defining and redefining problems, formulating the hypothesis or suggested solutions; collecting, organizing and evaluating data; making deductions and reaching conclusions; and at last carefully testing the conclusions to determine whether they fit the formulating hypothesis.

- The research is defined as “the manipulation of things, concepts or symbols for the purpose of generalizing to extend, correct or verify knowledge, whether that knowledge aids in construction of theory or in the practice of an art.

- Research is a logical and systematic search for new and useful information on a particular topic.

- Research can be described as a meticulous and purposeful endeavor, characterized by a methodical pursuit of knowledge or the formulation of novel theories.

- This pursuit is driven by an innate curiosity to uncover the unknown and apply it meaningfully within a specific context, thus contributing to the expansion of the existing knowledge reservoir.

- Research entails the construction or redefinition of hypotheses, the proposition of solutions, meticulous data analysis, and the validation of conclusions against these hypotheses.

- At its core, research is a creative process, generating knowledge where none previously existed

- The research cycle initiates from a pragmatic problem space. It is imperative to have a clear understanding of the problem that necessitates resolution and the reasons behind its significance.

- This problem serves as the catalyst for the formulation of a research question, a crucial compass that guides one through the overwhelming sea of information.

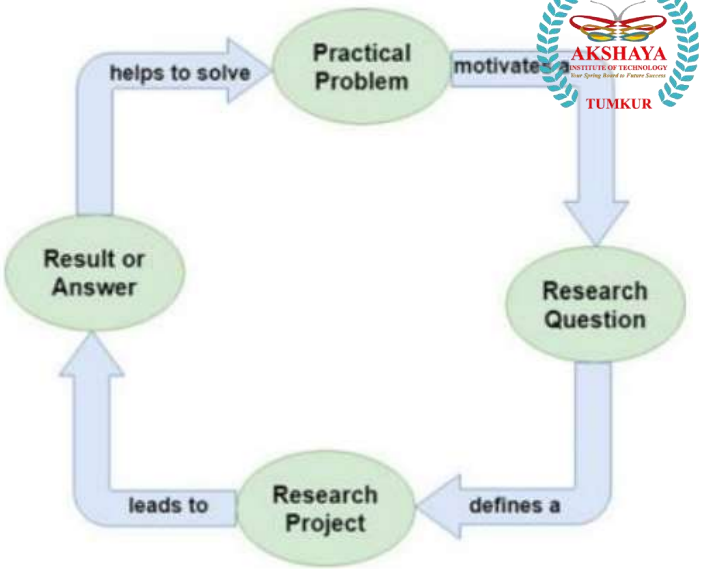

Fig. The research flow diagram

- By anchoring the inquiry, this question aids in narrowing down the vast array of data to a manageable scope. This, in turn, lays the groundwork for a research projects—an assortment of activities leading towards a conclusive result or answer. Ultimately, this outcome feeds back into resolving the initial practical problem, as illustrated in Figure.

1.2.Objectives of Engineering Research

- The main aim of research is to find out the truth which is hidden and which has not been discovered till today. Each research study has its own specific purpose.

- The prime objectives of research are as follows.

1. To discover the new facts.
2. To verify and test the important facts.
3. To analyze an event or process or phenomenon to identify the cause and effect relationship
4. To develop new scientific tools, concepts and theories to solve and understand scientific and nonscientific problems.
5. To find solutions to scientific, nonscientific and social problems.
6. To overcome or solve the problems occurring in our everyday life.

1.3.Motivation in Engineering Research

The potential reasons for engagement can stem from one or a combination of the following aspirations.

(i) Research indicates that intrinsic motivations such as interest, challenge, learning, meaning, and purpose correlate with elevated creative performance.

(ii) Extrinsic motivators like rewards for exemplary work, encompassing monetary gains, fame, awards, praise, and elevated status, wield considerable influence. However, they might potentially hinder creativity. For instance, the outcome of research might lead to a patent acquisition, promising wealth and renown.

(iii) External influences, including competition, collaboration, commitment, and encouragement, equally contribute to motivational dynamics. For example, being spurred by friends' involvement in research or striving to surpass a disliked individual's accomplishments.

The possible motives for doing research may be either one or more of the following:

1. Desire to get a research degree along with its consequential benefits.
2. Desire to face the challenge in solving the unsolved problems, i.e., concern over practical problems initiate the research.
3. Desire to get intellectual joy of doing some creative work.
4. Desire to be of service to society.
5. Desire to get respectability.
6. Curiosity about unknown
7. Desire to understand the cause and effect of wide spread social problems
8. Appearance of novel and unanticipated situations
9. Desire to discover new and test old scientific procedure as an efficient way to gain useful and fundamental knowledge.

1.4.Types of Engineering Research

(i) Descriptive vs. Analytical:

- Descriptive research includes surveys and fact-finding enquiries of different kinds.
- Descriptive research attempts to determine, describe, or identify the state as it exists at present.
- It uses description, classification, measurement and comparison to describe a situation.
- The survey method is commonly used in descriptive research.

- Analytical research is a continuation of descriptive research. The researcher attempts to analyze and explain why or how something is happening. Thus, analytical research aims to understand phenomena by discovering and measuring causal relations among them.

(ii)Applied vs. Fundamental:

Applied research aims at finding a solution for an *immediate problem* facing a society or an industrial/business organization.

It deals with practical problems. In the present world situation, more importance is being given to applied research to solve problems.

"Gathering knowledge for knowledge's sake is termed 'pure' or 'basic' research." The fundamental research is mainly concerned with generalisations and with the formulation of a theory.

Basic research is conducted to satisfy any curiosity such as:

(a) what makes things happen,
(b) why society changes
(c) why social relations are in a certain way.

Difference between Applied Research and Fundamental Research

Applied Research

- Tries to eliminate the theory by adding to the basics of a discipline.
- Problems are analysed from the point of one discipline.
- Generalisations are preferred.
- Forecasting approach is implemented.
- Assumes that other variables do not change.
- Reports are compiled in a language of technical language of discipline.

Fundamental Research

- Aims to solve a problem by adding to the field of application of a discipline.
- Often several disciplines work together for solving the problem.
- Often researches individual cases without the aim to generalise.
- Aims to say how things can be changed.
- Acknowledges that other variables are constant by changing.
- Reports are compiled in a common language.

(iii) Quantitative vs. Qualitative:

Quantitative research is based on the measurement of quantity or amount. Here a process is expressed or described in terms of one or more quantities.

The result of this research is essentially a number or a set of numbers. Quantitative research is more concerned with questions about: how much? How many? How often? To what extent? etc.

Quantitative research employs statistical analysis across a representative case pool for conclusive outcomes.

Quantitative research/ method are:

- it is numerical, non-descriptive, applies statistics or mathematics and uses numbers.
- It is an iterative process whereby evidence is evaluated.
- The results are often presented in tables and graphs.
- It is conclusive.
- It investigates the what, where and when of decision making.

Qualitative research is undertaken to gain insights. Insights concerning the attitudes, beliefs, motivations and behaviors of individuals to behave in a particular manner.

Qualitative research is concerned with finding the answers to questions which begin with: why? How? In what way?

Qualitative research is concerned with qualitative phenomenon involving quality. Some of the characteristics of qualitative research/method are:

- It is non-numerical, descriptive, applies reasoning and uses words.
- Its aim is to get the meaning, feeling and describe the situation.
- Qualitative data cannot be graphed.
- It is exploratory.
- It investigates the why and how of decision making.

(iv) Conceptual vs. Empirical Research:

- Conceptual research focuses on the concept (abstract/ideas) or theory that explains the phenomenon being studied.
- The conceptual researcher sits at his desk with pen in hand and tries to solve these problems by thinking about them.
- Here, the researcher tackles the problem part by part. He breaks down the concept into smaller simpler parts to understand it better.
- In empirical research, data collection is done through observation and experimentation.
- It is data-based research, coming up with conclusions which are capable of being verified by observation or experiment. It is also known as experimental type of research.

1.5.Finding and Solving a Worthwhile Problem

- In the world of Engineering success often comes on the ability to identify and solve the right problems worth solving. However, tackling an issue without fully understanding its worth can lead to wasted time and resources.

- The process of determining which problems are worth solving and how to address them effectively, ensuring a greater likelihood of success.

- Identify and reframe problems worth solving through research, observation, customer conversations and collaborative problem-solving techniques.

- Evaluate market demand to ensure successful solutions by leveraging technology and resources.

- Build trust with customers by providing consistent problem-solving strategies that create value.

Certain problems are universally recognized as challenging and open-ended, encompassing deep implications and connections across concepts.

George Pólya (1887–1985) proposed a 4-step framework for mathematical problem-solving, which holds relevance for engineering researchers as well

- Grasping the problem, rephrasing it as if it were one's own, visually representing it with diagrams, and assessing the need for supplementary information.

- Initiating exploration systematically, aiming to uncover potential strategies to resolve the problem or a simplified iteration of it, all while identifying recurring patterns.

- Executing the devised plan to assess its efficacy, and if unsuccessful, reinitiating with an alternative approach. Multiple engagements with the problem, interspersed with breaks, could spark fresh insights or novel ideas.

- Reflecting on the journey and outcomes aids in comprehending and internalizing the chosen strategy, an investment that benefits future pursuits.

1.6 Ethics in Engineering Research

- Ethics generally refers to a set of rules distinguishing acceptable and unacceptable conduct, distinguishing right from wrong.

- Most people learn such norms in their formative years, but moral development continues through different stages of growth.

- Ethical principles can be used for evaluation, proposition or interpretation of laws. Although ethics are not laws, but laws often follow ethics because ethics are our shared values.

International norms for the ethical conduct of research have been there since the adoption of the Nuremberg Code in 1947.

The issues related to research credit dates back to the establishment of the British Royal Society (BRS) in the seventeenth century to refine the methods and practices of modern science.

This event altered the timing and credit issues on the release of research results since BRS gave priority to whoever first submitted findings for publication, rather than trying to find out who had first discovered.

Whitbeck [4] raised two simple but significant questions to address the tricky issue of authorship in research:
(1) who should be included as an author and
(2) the appropriate order of listing of authors. In an increasingly interconnected world, the issue of coauthorship is very relevant to all researchers.

1.7 Ethics in Engineering Research Practice

- Technological developments raise a whole range of ethical concerns such as privacy issues and data related to surveillance systems, and so engineering researchers need to make ethical decisions and are answerable for the repercussions borne out of their research as outcomes.

- The reason that ethics matter in data used in engineering research is usually because there is impact on humans.

- Certain practices may be acceptable to certain people in certain situations, and the reasons for unacceptability may be perfectly valid.

Researchers make many choices that matter from an ethical perspective and influence the effects of technology in many different ways:

(i) By setting the ethically right requirements at the very outset, engineering researchers can ultimately influence the effects of the developed technology.

(ii) (ii) Influence may also be applied by researchers through design (a process that translates the requirements into a blueprint to fulfill those requirements). During the design process, decision is to be made about the priority in importance of the requirements taking ethical aspects into consideration.

(iii) (iii) Thirdly, engineering researchers have to choose between different alternatives fulfilling similar functions.

1.8 Types of Research Misconduct

- Engineering research should be conducted to improve the state-of-the-art of technologies. Research integrity encompasses dealing fairly with others, honesty about the methods and results, replicating the results wherever possible so as to avoid errors, protecting the welfare of research subjects, ensuring laboratory safety, and so forth.

- In order to prevent mistakes, peer reviews should take place before the research output is published.

- There may be different types of research misconduct as described in research article which can be summarized as follows:
    i) Fabrication
    ii) Falsification
    iii) Plagiarism

(i) Fabrication (Illegitimate creation of data):

Fabrication is the act of conjuring data or experiments with a belief of knowledge about what the conclusion of the analysis or experiments would be, but cannot wait for the results possibly due to timeline pressures from supervisor or customers.

(ii) Falsification (Inappropriate alteration of data): Falsification is the misrepresentation or misinterpretation, or illegitimate alteration of data or experiments, even if partly, to support a desired hypothesis even when the actual data received from experiments suggest otherwise.

Falsification and fabrication of data and results, hamper engineering research, cause false empirical data to percolate in the literature, cause actual and avoidable delays in technical advancement. Misleading data can also crop up due to poor design of experiments.

(iii) Plagiarism (Taking other's work sans attribution): Plagiarism takes place when someone uses or reuses the work (including portions) of others (text, data, tables, figures, illustrations or concepts) as if it were his/her own without explicit acknowledgement.

Verbatim copying or reusing one's own published work is termed as self-plagiarism and is also an unacceptable practice in scientific literature. The increasing availability of scientific content on the internet seems to encourage plagiarism in certain cases, but also enables detection of such practices through automated software packages.

How are supervisors, reviewers or editors alerted to plagiarism?

(i) Original author comes to know and informs everyone concerned.
(ii) Sometimes a reviewer finds out about it during the review process.
(iii) Or, readers who come across the article or book, while doing research.

iv) Other Aspects of Research Misconduct

- Serious deviations from accepted conduct could be construed as research misconduct. When there is both deception and damage, a fraud is deemed to have taken place.

- Sooner or later ethical violations get exposed. Simultaneous submission of the same article to two different journals also violates publication policies.

- Another issue is that when mistakes are found in an article or any published content, they are generally not reported for public access unless a researcher is driven enough to build on that mistake and provide a correct version of the same which is not always the primary objective of the researcher.

1.9 Ethical Issues Related to Authorship

- Academic authorship involves communicating scholarly work, establishing priority for their discoveries, and building peer-reputation, and comes with intrinsic burden of acceptance of the responsibility for the contents of the work.

- Credit for research contributions is attributed in three major ways in research publications: by *authorship* (of the intended publication), *citation* (of previously published or formally presented work), and through a written *acknowledgment* (of some inputs to the present research).

- Authorship establishes both accountability and gives due credit. A person is expected to be listed as an author only when associated as a significant contributor in research design, data interpretation, or writing of the paper.

- Including “guest” or “gift” authors dilutes the contribution of those who actually did the work, inappropriately inflates credentials of the listed authors and is ethically a red flag highlighting research misconduct .

- Sometimes, the primary author dubiously bestows coauthorship on a junior faculty or a student to boost their chances of employment or promotion, which can be termed as Career-boost authorship.

- Sometimes, an actual contributor abstains from the list of authors due to nondisclosed conflict of interest within the organization. Such coauthorships can be termed as ghost coauthorship.

- Full disclosure of all those involved in the research is important so that evaluation can happen both on the basis of findings, and also whether there was influence from the conflicts.

- Some authors, in trying to acquire a sole-authored work, despite relying on significant contribution to the research work from others, recognize that effort only by an acknowledgment, thereby misrepresenting the contributions of the listed authors.

- All listed authors have the full obligation of all contents of a research article.

- Double submission is an important ethical issue related to authorship, which involves submission of a paper to two forums simultaneously.

- The motivation is to increase publication possibility and possibly decrease time to publication. Reputed journals want to publish original papers, i.e., papers which have not appeared elsewhere, and strongly discourage double submission.