

Terms

RESEARCH METHODOLOGIES

RESEARCH

The word research is composed of two syllables, re and search.

re is a prefix meaning again, anew or over again

search is a verb meaning to examine closely and carefully, to test and try, or to probe.

a noun describing a systematically established & acceptable analytical data with relevant & careful, hypothesis. It is investigation in some field of knowledge, undertaken to establish facts or principles.

Method - a **series of steps** taken to complete a certain task or to reach a certain objective

Methodology - the **study of the methods** involved in some field, or in problem solving
Methodology is defined as

"the analysis of the principles of methods, rules, and postulates employed by a discipline"; "the systematic study of methods that are, can be, or have been applied within a discipline"; or "a particular procedure or set of procedures."

- a collection of theories, concepts or ideas
- comparative study of different approaches
- critique of the individual methods

Methodology refers to more than a simple set of methods;

it refers to the rationale and the philosophical assumptions that underlie a particular study.

CHARACTERISTICS OF RESEARCH:

- It demands a clear statement of the problem
- It requires a plan (it is not aimlessly “ looking” for something in the hope that you will come across a solution)
- It builds on existing data, using both positive and negative findings
- New data should be collected as required and be organized in such a way that they answer the research question(s)

This can be achieved to a large extent in the physical sciences (cooking bakery), as most of the research is done in a laboratory. answers to questions are relevant, appropriate and justified. Again, the degree of rigour varies markedly between the physical and social sciences and within the social sciences.

-Systematic-this implies that the procedure adopted to undertake an investigation follow a certain logical sequence. The different steps cannot be taken in a haphazard way. Some procedures must follow others.

-Valid and verifiable-this concept implies that whatever you conclude on the basis of your findings is correct and can be verified by you and others.

-Empirical-this means that any conclusion drawn are based upon hard evidence gathered from information collected from real life experiences or observations.

-Critical-critical scrutiny of the procedures used and the methods employed is crucial to a research enquiry. The process of investigation must be foolproof and free from drawbacks. The process adopted and the procedures used must be able to withstand critical scrutiny. For a process to be called research, it is imperative that it has the above characteristics.

TYPES OF RESEARCH

BASIC/FUNDAMENTAL / PURE

- ◆ It means formation of *theory* or *generalization*.
- ◆ Basic research is usually considered to involve a research for knowledge without a defined goal of utility or specific purpose.

APPLIED/ ACTION

- ◆ Solution for immediate problems.
- ◆ Applied research is problem oriented.

OTHER CATEGORIES OF RESEARCH

- ◆ Longitudinal / onetime. Field setting / laboratory / simulation.
- ◆ Clinical / diagnostic. Historical.
- ◆ Conclusion oriented / decision oriented.

Quantitative and Qualitative researches: Early forms of research originated in the natural sciences such as biology, chemistry, physics, geology etc. and was concerned with investigating things which we could observe and measure in some way. Such observations and measurements can be made objectively and repeated by other researchers. This process is referred to as “quantitative” research.

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

Quantitative research, on the other hand, is more concerned with questions about: how much? How many? How often? To what extent? etc.

OBJECTIVE OF RESEARCH:

From the viewpoint of objectives, a research can be classified as

- descriptive
- correlational
- explanatory
- exploratory

Descriptive research attempts to describe systematically a situation, problem, phenomenon, service or programme, or provides information about , say, living condition of a community, or describes attitudes towards an issue.

Correlational research attempts to discover or establish the existence of a relationship/ interdependence between two or more aspects of a situation.

Explanatory research attempts to clarify why and how there is a relationship between two or more aspects of a situation or phenomenon.

Exploratory research is undertaken to explore an area where little is known or to investigate the possibilities of undertaking a particular research study.

MOTIVATION IN RESEARCH

What makes people to undertake research? This is a question of fundamental importance. 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 initiates 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.

However, this is not an exhaustive list of factors motivating people to undertake research studies. Many more factors such as directives of government, employment conditions, curiosity about new things, desire to understand causal relationships, social thinking and awakening, and the like may as well motivate (or at times compel) people to perform research operations.

Research Approaches

There are two basic approaches to research, viz.,

- 1) *quantitative approach*
- 2) *qualitative approach*.

1) quantitative approach

The former involves the generation of data in quantitative form which can be subjected to rigorous quantitative analysis in a formal and rigid fashion. This approach can be further sub-classified into

- a) *Inferential* (b) *experimental* and (c) *simulation approaches* to research.

- (a) The purpose of *inferential approach* to research is to form a data base from which to infer characteristics or relationships of population. This usually means survey research where a sample of population is studied (questioned or observed) to determine its characteristics, and it is then inferred that the population has the same characteristics. Let us consider water samples of fifteen places of different area which physico chemical properties are taken in data base to infer are characteristics.
- (b) *Experimental approach* is characterised by much greater control over the research environment and in this case some variables are manipulated to observe their effect on other variables. *Physico chemical properties affect* on different condition of environment are studied.
- (c) *Simulation approach* involves the construction of an artificial environment within which relevant information and data can be generated. This permits an observation of the dynamic behaviour of a system (or its sub-system) under controlled conditions.
- (2) *Qualitative approach* to research is concerned with subjective assessment of attitudes, opinions and behaviour. Generally, the techniques of focus group interviews, projective techniques and depth interviews are used. Research in such a situation is a function of researcher's insights and impressions. Such an approach to research generates results either in non-quantitative form or in the form which are not subjected to rigorous quantitative analysis.

Significance of Research

“All progress is born of inquiry. Doubt is often better than overconfidence, for

- 1) it leads to inquiry, and inquiry leads to invention” is a famous Hudson Maxim in context of which the significance of research can well be understood.
- 2) Increased amounts of research make progress possible.

- 3) Research, as an aid to economic policy, has gained added importance, both for government and business. *Research provides the basis for nearly all government policies in our economic system.* For instance, government's budgets rest in part on an analysis of the needs and desires of the people and on the availability of revenues to meet these needs. The cost of needs has to be equated to probable revenues and this is a field where research is most needed. Through research we can devise alternative policies and can as well examine the consequences of each of these alternatives Thus,
- 4) Research is considered necessary with regard to the allocation of nation's resources. Another area in government, where research is necessary, is collecting information on the economic and social structure of the nation. Such information indicates what is happening in the economy and what changes are taking place. Collecting such statistical information is by no means a routine task, but it involves a variety of research problems. These days nearly all governments maintain large staff of research technicians or experts to carry on this work. Thus, in the context of government, research as a tool to economic policy has three distinct phases of operation, viz., (i) investigation of economic structure through continual compilation of facts; (ii) diagnosis of events that are taking place and the analysis of the forces underlying them; and (iii) the prognosis, i.e., the prediction of future developments.
- 5) *Research has its special significance in solving various operational and planning problems of business and industry.* Operations research and market research, along with motivational research, are considered crucial and their results assist, in more than one way, in taking business decisions. Market research is the investigation of the structure and development of a market for the purpose of formulating efficient policies for purchasing, production and sales. Operations research refers to the application of mathematical, logical and analytical techniques to the solution of business problems of cost minimisation or of profit maximisation or what can be termed as optimisation problems. Motivational research of determining why people behave as they do is mainly concerned with market characteristics. In other words, it is concerned with the determination of motivations underlying the consumer (market) behaviour. All these are of great help to people in business and industry who are responsible for taking business decisions. Research with regard to demand and market factors has great utility in business. Given knowledge of future demand, it is generally not difficult for a firm, or for an industry to adjust its supply schedule within the

limits of its projected capacity. Market analysis has become an integral tool of business policy these days. Business budgeting, which ultimately results in a projected profit and loss account, is based mainly on sales estimates which in turn depends on business research. Once sales forecasting is done, efficient production and investment programmes can be set up around which are grouped the purchasing and financing plans. Research, thus, replaces intuitive business decisions by more logical and scientific decisions.

6) *Research is equally important for social scientists in studying social relationships and in seeking answers to various social problems.* It provides the intellectual satisfaction of knowing a few things just for the sake of knowledge and also has practical utility for the social scientist to know for the sake of being able to do something better or in a more efficient manner. Research in social sciences is concerned both with knowledge for its own sake and with knowledge for what it can contribute to practical concerns. “This double emphasis is perhaps especially appropriate in the case of social science. On the one hand, its responsibility as a science is to develop a body of principles that make possible the understanding and prediction of the whole range of human interactions. On the other hand, because of its social orientation, it is increasingly being looked to for practical guidance in solving immediate problems of human relations.”⁶ In addition to what has been stated above, the significance of research can also be understood keeping in view the following points:

- (a) To those students who are to write a master’s or Ph.D. thesis, research may mean a careerism or a way to attain a high position in the social structure;
- (b) To professionals in research methodology, research may mean a source of livelihood;
- (c) To philosophers and thinkers, research may mean the outlet for new ideas and insights;
- (d) To literary men and women, research may mean the development of new styles and creative work;
- (e) To analysts and intellectuals, research may mean the generalisations of new theories.

Thus, research is the fountain of knowledge for the sake of knowledge and an important source of providing guidelines for solving different business, governmental and social problems. It is a sort of formal training which enables one to understand the new developments in one’s field in a better way.

Research Methods versus Methodology

It seems appropriate at this juncture to explain the difference between research methods and research methodology. *Research methods* may be understood as all those methods/techniques that are used for conduction of research. *Research methods or techniques**, thus, refer to the methods the researchers

*At times, a distinction is also made between research techniques and research methods. *Research techniques* refer to the behaviour and instruments we use in performing research operations such as making observations, recording data, techniques of processing data and the like. *Research methods* refer to the behaviour and instruments used in selecting and constructing research technique. For instance, the difference between methods and techniques of data collection can better be understood from the details given in the following chart—

Type Methods Techniques

1. Library (i) Analysis of historical Recording of notes, Content analysis, Tape and Film listening and Research records analysis.
(ii) Analysis of documents Statistical compilations and manipulations, reference and abstract guides, contents analysis.
2. Field (i) Non-participant direct Observational behavioural scales, use of score cards, etc.
Research observation
(ii) Participant observation Interactional recording, possible use of tape recorders, photo graphic techniques.
(iii) Mass observation Recording mass behaviour, interview using independent observers in public places.

- (iv) Mail questionnaire Identification of social and economic background of respondents.
 - (v) Opinionnaire Use of attitude scales, projective techniques, use of sociometric scales.
 - (vi) Personal interview Interviewer uses a detailed schedule with open and closed questions.
 - (vii) Focused interview Interviewer focuses attention upon a given experience and its effects.
 - (viii) Group interview Small groups of respondents are interviewed simultaneously.
 - (ix) Telephone survey Used as a survey technique for information and for discerning opinion; may also be used as a follow up of questionnaire.
 - (x) Case study and life history Cross sectional collection of data for intensive analysis, longitudinal collection of data of intensive character.
3. Laboratory Small group study of random Use of audio-visual recording devices, use of observers, etc.

Research behaviour, play and role analysis

From what has been stated above, we can say that methods are more general. It is the methods that generate techniques. However, in practice, the two terms are taken as interchangeable and when we talk of research methods we do, by implication, include research techniques within their compass.

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use in performing research operations. In other words, all those methods which are used by the researcher during the course of studying his research problem are termed as research methods. Since the object of research, particularly the applied research, it to arrive at a solution for a given problem, the available data and the unknown aspects of the problem have to be related to each other to make a solution possible. Keeping this in view, research methods can be put into the following three groups:

1. In the first group we include those methods which are concerned with the collection of data. These methods will be used where the data already available are not sufficient to arrive at the required solution;
2. The second group consists of those statistical techniques which are used for establishing relationships between the data and the unknowns;
3. The third group consists of those methods which are used to evaluate the accuracy of the results obtained. Research methods falling in the above stated last two groups are generally taken as the analytical tools of research.

Research and Scientific Method

The scientific method is, thus, based on certain basic postulates which can be stated as under:

1. It relies on empirical evidence;
2. It utilizes relevant concepts;
3. It is committed to only objective considerations;
4. It presupposes ethical neutrality, i.e., it aims at nothing but making only adequate and correct statements about population objects;
5. It results into probabilistic predictions;
6. Its methodology is made known to all concerned for critical scrutiny are for use in testing the conclusions through replication;
7. It aims at formulating most general axioms or what can be termed as scientific theories. Thus, “the scientific method encourages a rigorous, impersonal mode of procedure dictated by the demands of logic and objective procedure.”¹⁰ Accordingly, scientific method implies an objective, logical and systematic method, i.e., a method free from personal bias or prejudice, a method to ascertain demonstrable qualities of a phenomenon capable of being verified, a method wherein the researcher is guided by the rules of logical reasoning, a method wherein the investigation proceeds in an orderly manner and a method that implies internal consistency.

Criteria of Good Research

Whatever may be the types of research works and studies, one thing that is important is that they all meet on the common ground of scientific method employed by them. One expects scientific research to satisfy the following criteria:¹¹

1. The purpose of the research should be clearly defined and common concepts be used.
2. The research procedure used should be described in sufficient detail to permit another researcher to repeat the research for further advancement, keeping the continuity of what has already been attained.
3. The procedural design of the research should be carefully planned to yield results that are as objective as possible.
4. The researcher should report with complete frankness, flaws in procedural design and estimate their effects upon the findings.
5. The analysis of data should be sufficiently adequate to reveal its significance and the methods of analysis used should be appropriate. The validity and reliability of the data should be checked carefully.
6. Conclusions should be confined to those justified by the data of the research and limited to those for which the data provide an adequate basis.
7. Greater confidence in research is warranted if the researcher is experienced, has a good reputation in research and is a person of

integrity. In other words, we can state the qualities of a good research¹² as under:

1. *Good research is systematic*: It means that research is structured with specified steps to be taken in a specified sequence in accordance with the well defined set of rules. Systematic characteristic of the research does not rule out creative thinking but it certainly does reject the use of guessing and intuition in arriving at conclusions.
2. *Good research is logical*: This implies that research is guided by the rules of logical reasoning and the logical process of induction and deduction are of great value in carrying out research. Induction is the process of reasoning from a part to the whole whereas deduction is the process of reasoning from some premise to a conclusion which follows from that very premise. In fact, logical reasoning makes research more meaningful in the context of decision making.
3. *Good research is empirical*: It implies that research is related basically to one or more aspects of a real situation and deals with concrete data that provides a basis for external validity to research results.
4. *Good research is replicable*: This characteristic allows research results to be verified by replicating the study and thereby building a sound basis for decisions.

Preparation of the Report or Presentation of Results

Steps in Research Process:

Scientific Research Steps

1 *Formulation of problems*

Find a topic→What, When

Formulate questions→What, Why

2. *Extensive Literature Review*

Define population→Who, When

3 *Developing/Setting research objectives*

Select design & measurement→How

4 *Preparing the Research Design*

Sample including Sample Design

Gather evidence→How

5 *Methods of data collection*

6 *Analysis of Data*

7 *Generalisation and Interpretation*

Interpret evidence→Why

8. *Preparation of the Report or*

Presentation of results

Tell about what you did and found out

Step 1: Formulate Research question / Problem

The most important step in research !

Often comes from the thought:

“What we have now is not quite right/good enough – we can do better ...”

The research question defines the “area of interest” but it is not a

declarative statement like a hypothesis.

The central research question may be complemented by

a few secondary questions to narrow the focus.

Research question must be capable of being confirmed or refuted.

The study must be feasible.

Research question / Problem - Examples

EXAMPLE (1 single question)

“Which methods and tools should be developed to make current manufacturing control / supervision systems reusable and swiftly modifiable?”

EXAMPLE (multiple questions)

“Q1: What are the main component“Which methods and tools should be developed to make current manufacturing control / supervision systems reusable and swiftly modifiable?” of logistics costs that determine the logistics and transport network design?

Q2: To what extent are the existing network design and evaluation models sufficient and how can collaboration be incorporated in the network design methodology?

Q3: How can economies of scale and scope, present in the newtork, be taken into account in the network design?

Q4: Is it possible to set boundaries to the development path of the network, and search for a feasible path instead of searching solely for a feasible solution? “

Research question / Problem - Examples

EXAMPLES WITH SOME PROBLEMS:

“The main objective of this work is to contribute to the development of elements of a formal theory for manufacturing systems in order to allow the

“The main research questions which have guided this research work are:

Q1: Which are the main characteristics of a collaborative network and of a collaborative networked environment?

Q2: How can be assessed the performance of a CN?

Q3: Which are the most relevant conceptual frameworks, architectures, reference models, independent and industry specific initiatives, ICT platforms and their underlying technologies, targeting interoperability in a collaborative networked environment?

Q4: Which are the main requirements for interoperability in

establishment of a formal methodology for the design and analysis of manufacturing systems”

It states the “idea” ... but is not formulated as a research question ... and sounds vague.

a networked environment?

Q5: How can seamless interoperability be achieved?

Q6: Which are the main differences and similarities between existing conceptual frameworks?

Q7: How can conceptual frameworks be compared, and which are the criteria to support such an analysis and evaluation?

Q8: Do the conceptual frameworks and the technological solutions compete or complement each other?

Q9: Which is the path to be followed to allow heterogeneous and geographically distributed organizations to naturally inter-operate?

Too many, no hierarchy, some redundancy.

Step 2: Background / Observation

How has the work been done previously? What similar work has been leading up to this point? Study state of the art (literature review, projects, informal discussions, etc). Optional realization of preliminary experiments. What distinguishes previous work from what you want to do? Who / What will be impacted by this research?

Step 3: Formulate hypothesis

A scientific hypothesis states the ‘predicted’ (educated guess) relationship amongst variables. Serve to bring clarity, specificity and focus to a research problem

... But are not essential

... You can conduct valid research without constructing a hypothesis

... On the other hand you can construct as many hypothesis as appropriate

Stated in declarative form. Brief and up to the point.

A possible format (formalized):

“**If then** (because) “ In the case of a **PhD dissertation**, one hypothesis after tested becomes a **thesis** being defended. One dissertation may include more than one thesis.

Sometimes people refer to the dissertation as the “thesis”.

Step 4: Design experiment

Includes planning in detail all the steps of the experimental phase. What needs to be controlled in order to get an unbiased answer to the research question. Therefore: it is necessary to not only design a prototype / system but also the thesis validation method !

How to validate the thesis?

The plan should allow others to repeat it.

It should be feasible...!

Plan intermediate milestones.

If you fail to plan, you planned to fail !

Step 5: Test hypothesis / Collect data

Doing it !

Implementation of methods (e.g. prototyping) and auxiliary tools (e.g. simulation)

Pilot testing and refinement.

Field vs. Laboratory work.

Confirm results by retesting !

Step 6: Interpret / Analyze results

What did your experiment show?

Qualitative data analysis.

Quantitative data analysis.

Descriptive and inferential statistics, clustering, ...

What might weaken your confidence in the results (critical spirit)

Discussion regarding Literature Research objectives

Research questions. Consider next steps

Recommendations for further research.

Step 7: Publish findings

A research result is not a contribution to the field if no one knows about it or can use it !

Write scientific papers, make presentations

Intermediate results

Conferences

Collect feedback

“Publish or perish !”

Consolidated results Journals

Be careful in selecting where you publish !

Write dissertation

Is it a good thesis ?

How do you know if you've got a solid tentative thesis?

Try these five tests:

Does the thesis inspire a reasonable reader to ask, "How?" or Why?“

Would a reasonable reader NOT respond with "Duh!" or "So what?" or "Gee, no kidding!" or "Who cares?“

Does the thesis avoid general phrasing and/or sweeping words

Is it a good thesis ?

such as "all" or "none" or "every"?

Does the thesis lead the reader toward the topic sentences
(the subtopics needed to prove the thesis)?

Can the thesis be adequately developed in the required length of the
paper or dissertation?

MORE: Can you “prove” it ?

1) *Criteria for selecting a research topic(Problem)*

1. **Relevance:** The topic you choose should be a priority problem:

Questions to be asked include:

- ☐ ***How large or widespread is the problem?***
- ☐ ***Who is affected?***
- ☐ ***How severe is the problem?***

2. **Avoidance of duplication:** Investigate whether the topic has been researched.
If the topic has been researched, the results should be reviewed to explore whether major questions that deserve further investigation remain unanswered. If not, another topic should be chosen.

3. **Feasibility:** Consider the complexity of the problem and the resources you will require to carry out the study.

Thought should be given first to personnel, time, equipment and money that are locally available. In situations where the local resources necessary to carry out the project are not sufficient, you might consider sources available at the national level.

4. **Political acceptability:** It is advisable to research a topic that has the interest and support of the authorities. This will facilitate the smooth conduct of the research and increases the chance that the results of the study will be implemented.

5. **Applicability of possible results and recommendations**

Is it likely that the recommendations from the study will be applied? This will depend not only on the blessing of the authorities but also on the availability of resources for implementing the recommendations

b) Scales for rating research topics

Relevance

- 1 = Not relevant
- 2 = Relevant
- 3 = very relevant

Avoidance of duplication

- 1 = Sufficient information already available
- 2 = Some information available but major issues not covered
- 3 = No sound information available on which to base problem-solving

Feasibility

- 1 = Study not feasible considering available resources
- 2 = Study feasible considering available resources
- 3 = Study very feasible considering available resources

Political acceptability

- 1 = Topic not acceptable
- 2 = Topic somewhat acceptable
- 3 = Topic fully acceptable

Applicability

- 1 = No chance of recommendations being implemented
- 2 = Some chance of recommendations being implemented
- 3 = Good chance of recommendations being implemented

Rating scale: 1 = low, 2 = medium, 3 = high

3) Learning objectives

After completing this chapter, the student should be able to:

1. Describe the advantages of a systematic analysis of a problem
2. Describe the importance of a clear statement of a problem
3. Enumerate the points that should be included in the statement of a problem

Scope of Research

- Ph.D. students – contribution expected at world level; e.g.
 - background investigation on all past work
 - make meaningful addition to world knowledge