



Research Methods and Professional Development

ACFA7004

Research methodology – Part 1

Dr Seena Joseph

Research methodology

- A systematic approach to conduct research including the methods, techniques, and tools for collecting and analyzing data to solve a specific problem.
- Research methodology is influenced by philosophical assumptions.
- **Epistemology** and **ontology** are the underlying philosophical concepts that influence the choices made throughout the research process.

Research methodology

- **Garden Story** : Let's imagine we are curious why some plants in our garden grow taller than others.
 - **Outer Layer: Research Philosophy (Ontology & Epistemology)**
 - **Ontology**: Are growth differences real or just perception?
 - **Epistemology**: How do we know — measure plants or ask gardeners?
 - **Philosophy**:
 - Positivism → measure plants & sunlight
 - Interpretivism → ask gardeners' experiences
 - Realism → combine measurement & hidden factors
 - Pragmatism → use whatever works best
 - **Approach**:
 - Deductive → test theory: “More sunlight makes plants taller”
 - Inductive → observe patterns without prior theory

Research methodology

- **Research strategy**

- Experiment → change sunlight for some plants and measure growth
- Survey → ask gardeners for their practices
- Case study → focus on one section of the garden
- Action research → try new watering techniques and observe results
- Ethnography → immerse yourself in gardeners' routines to understand practices
- Archival research → check old garden records or journals to see past growth patterns

- *Not all strategies fit every research problem. For our garden example, experiment, survey, and case study work well. Action research or archival research could be used if we intervene or have past records. Ethnography is usually for studying people or culture, so it's less relevant here.*

Research methodology

- **Methodology:**
 - Quantitative → measure plant height, sunlight
 - Qualitative → ask gardeners for care practices
 - Mixed → combine both
- **Time Horizon:**
 - Cross-sectional → measure once
 - Longitudinal → track growth over a season
- **Data collection and analysis**
 - Measure height with ruler, record sunlight daily
 - Analyse data with charts, averages, or comparisons

Research methodology

- 1. **Epistemology** (The Study of Knowledge)
 - How we know what we know ? Or How do we gain knowledge ?
- What is knowledge?
- How do we acquire knowledge?
- How do we justify our beliefs or claims to know something?
- Can knowledge be objective (true for everyone) or is it subjective (personal)?
- If you believe that knowledge comes from observable facts and measurable data, you might follow a positivist epistemology (often used in quantitative research).
- If you believe that knowledge comes from understanding human experiences and context, you might follow an interpretivist epistemology (often used in qualitative research).

Research methodology

2. Ontology (The Study of Existence or Reality)

- Ontology is concerned with the nature of reality and existence: what is out there in the world and how we understand it.
- It explores questions like:
 - What is the nature of reality?
 - What kinds of things exist in the world?
 - Are there objective realities that exist independently of us (external reality), or is reality shaped by our perceptions (subjective reality)?
 - How do we categorize and classify things in the world?
- Epistemology and ontology are closely linked because they both help researchers decide how to approach their research and what to study.

Selecting the methodology

How do we guide the Research Process?

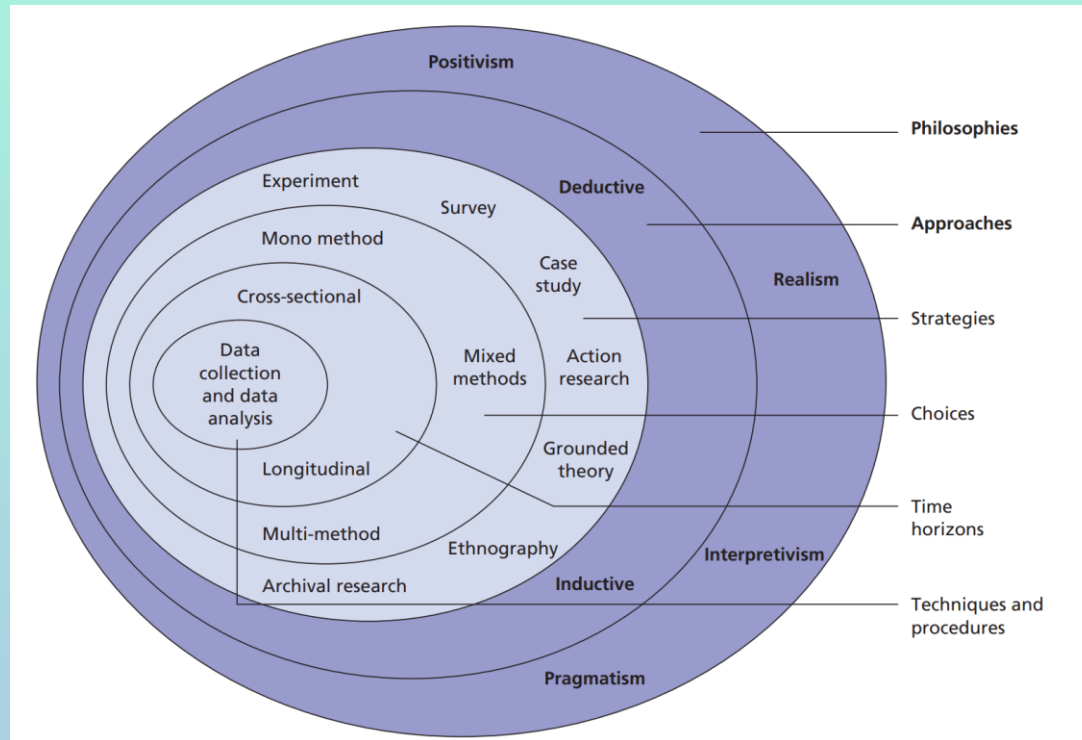
The **research Onion** modelled by Saunders Guide the research process. The **Research Onion** is a layered framework that guides you through different stages of research, starting from the philosophy and approach down to the techniques and procedures.

It is a framework used to explain the various stages involved in developing a research.

It is a layered framework that guides you through different stages of research, starting from the philosophy and approach down to the techniques and procedures.

Selecting the methodology

Research Onion



(Saunders et al., [1])

Selecting the methodology

- **Research Philosophy**

- Philosophy explores how the observer influences knowledge acquisition, delving into whether knowledge can possess inherent objectivity or subjectivity.
- Based on how knowledge is created.
- About the underlying beliefs and principles that guide how we study the world and gather knowledge.
- **Objective Knowledge:** It is independent of our personal feelings, opinions, or perspectives.
 - *E.g. A computer will execute the same code in the same way every time, provided the environment remains the same.*
- **Subjective Knowledge:** On the other hand, subjective knowledge is shaped by our personal experiences, feelings, and perspectives.
 - *E.g. “This software is easy to use.”*
 - *This is subjective knowledge because what one person finds easy to use, another person might find complicated.*

Selecting the methodology

Three common philosophies

Positivism, Interpretivism, and Pragmatism

1. **Positivism** – Asserts that knowledge is absolute and objective, positing the existence of a singular and objective reality.

Knowledge should be based on observable facts and objective evidence.

Reality is measurable ; Data, numbers and experiments

- This is common in computer science when you use algorithms or mathematical models.
- Positivism in computer science might involve testing and measuring things in a factual and objective way, like comparing the performance of two algorithms.

Selecting the methodology

Three common philosophies

Positivism, **Interpretivism**, and Pragmatism

2. **Interpretivism** – understanding the meaning behind human experiences and personal perspectives.

Reality is based on human experience. Interviews, perceptions, opinions.

- In computer science, this might apply in fields like user experience or human-computer interaction
- Interpretivism in computer science would focus on understanding human experiences and personal insights about how technology is used, like exploring developers' feelings about a tool.

Selecting the methodology

Three common philosophies

Positivism, Interpretivism, and **Pragmatism**

3. Pragmatism is a practical approach to solving problems.

It focuses on what works best in a given situation, rather than sticking to a particular method or theory.

Use whatever works to answer the question.

Example: Imagine you're designing a software application, and you have two approaches to handle user authentication: one is based on the latest security framework (which is complicated and takes more time to implement), and the other is a simpler, well-tested method that works just fine for your application.

A pragmatist would say: "Let's go with the simpler, well-tested method because it will save time and still meet our needs." They care about getting the work done effectively, not necessarily using the most complex or advanced solution.

Selecting the methodology

Research Approach

Two common Approaches : Deductive and inductive

1. Deductive approach to theory

- Verify existing theories and associated propositions or hypotheses
- Start with a theory or hypothesis and then design research strategy to test the hypothesis/theory.
- Eg: Hypothesize : Support Vector Machines (SVM) will perform better than Decision Trees in detecting malware.
- Is suitable when your research topic has a wealth of literature from which you can define a theoretical framework and a hypothesis
- Is about using theory to identify what data you need to collect

Selecting the methodology

2. Inductive approach to theory

- Start with observing pattern or collecting and analysing data then developing a theory.
- Inductive research generalizes findings from empirical evidence to formulate new theories

Eg: You develop a description of how businesses use Facebook for advertising based upon a survey of local businesses

- Is suitable when the topic is new, has much debate and/or there is little existing literature
- Is about gathering data and trying to generate theories from it

Selecting the methodology

Research strategy

Research strategy : A roadmap for researchers; A research strategy provides a framework for organizing the research process, collecting and analyzing data, and interpreting findings.

1. Experiment
2. Software development
3. Survey
4. Case study
5. Action research
6. Ethnography

Selecting the methodology

Research strategy - Experiment

Experimentation sets out to examine the relationship between two factors (or variables) by manipulating one whilst measuring changes in the other

- Hypothesis : Your big question
 - It must be phrased in a testable form
- Experimental variables

The factors you are going to investigate

Independent variable (IV) – the thing you’re going to control or manipulate

Dependent variable (DV) – the thing you’re going to measure

Aim for: changes in the IV cause changes in the DV

Experiments are used to determine if a causal relationship exists - in other words, if the alteration of one variable ‘causes’ a change in another

Selecting the methodology

Research strategy - Experiment

Examples:

- We may test out three different e-commerce website designs and measure the effect on usability.
- A computer scientist conducts an experiment to evaluate the performance of different machine learning algorithms for sentiment analysis.
 - The researcher manipulates variables such as algorithm type, training dataset size, and feature selection methods. By measuring accuracy, precision, and recall on a standardized dataset, the researcher can determine which algorithm performs best under various conditions.

Selecting the methodology

Research strategy – Software development

- This strategy involves developing novel software and testing that, it works effectively
- Software development projects
 - Designing and building a database to act as a scheduling system
 - Designing and building a game-playing robot
 - Designing and building an educational website
 - Designing and building a website to collect usability data
- Not software development projects
 - Using an existing website to collect questionnaire data

Selecting the methodology

Research strategy – Survey

- An investigation into opinions through questionnaires or interviews
- The design of questionnaires and interviews is complex and must be prototyped before use
- All questions must be written with great care
- Respondents are questioned either verbally, in writing or via computer and their responses noted
- May be able to generalise from small samples to large populations
- Good for getting large amounts of subjective data in a short amount of time
- Good for ‘what’ and ‘how’ questions

Example

1. A marketing researcher conducts a survey to assess customer satisfaction with a new product. The survey asks participants to rate their satisfaction levels on a scale and provide feedback on various aspects of the product.
2. A software developer conducts a survey to gather feedback from users about the usability of a mobile application

Selecting the methodology

Research strategy – Case study

- A case study is an intensive examination of a single instance of a phenomenon of interest

E.g. a company, an event, a process or a technology

- Involves gathering very detailed data and using it to explain what is happening
- Can be very time-consuming and requires good access to the phenomenon of interest
- Example:
 - Visiting schools to investigate the use of iPads in the classroom.
 - Cybersecurity analyst conducts a case study on a data breach incident to understand the root causes and mitigation strategies. The analyst examines the sequence of events, vulnerabilities exploited, and responses taken by the affected organization.

Selecting the methodology

Research strategy –Action research

- Action research is a process where the researcher is simultaneously trying to investigate and solve a problem.
- The investigator should be part of the community impacted by the results of the research
- Collaboration between researchers and practitioners to address practical problems or improve practices in real-world settings. It typically follows a cyclical process of planning, action, observation, and reflection.
- Often used in education and business

Selecting the methodology

Research strategy –Action research

Example:

- An educator collaborates with teachers to implement a new teaching method aimed at improving student engagement in the classroom. The educator observes the method in action, collects feedback from teachers and students, and adjusts the approach based on the results.
- A network administrator collaborates with system users to address performance issues in a company's IT infrastructure. The administrator implements network monitoring tools to identify bottlenecks and performance bottlenecks.

Selecting the methodology

Research strategy – Ethnography

- Ethnography involves immersive, long-term fieldwork in naturalistic settings to study cultural phenomena from the perspective of participants.
- Ethnography is a qualitative research method where the researcher embeds themselves into an organization to study how that organization works.
- Researchers engage in participant observation, interviews, and document analysis to understand the cultural context and practices of a group or community.

Example:

- An anthropologist conducts ethnographic research in a rural village to study traditional farming practices. The researcher lives among the villagers, participates in daily activities, and documents agricultural techniques, rituals, and social dynamics.
- A computer scientist conducts ethnographic research to study the culture and practices of software development teams in a large technology company

Selecting the methodology

Research method

Methodological choice : Deals with the type of data that will be collected and analysed.

- Qualitatively (Mono method)
- Quantitatively (Mono method)
- Mixed method - Combination of qualitative and quantitative methods
- Multi method – one method either qualitative or quantitative; twice or more during the course of the research

Selecting the methodology

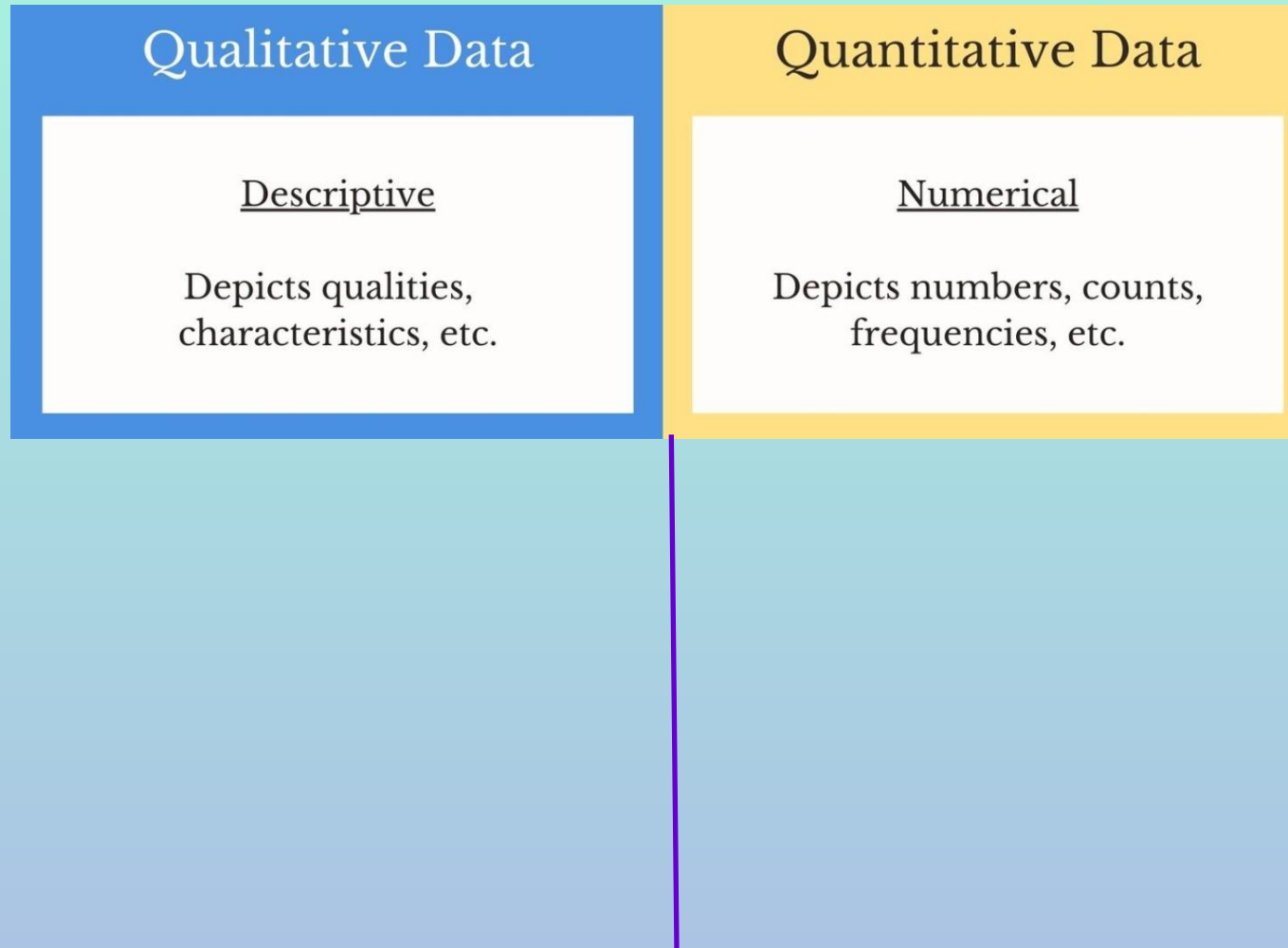
Research approach – Activity

For each of the nine projects, identify a suitable approach and strategy for the study. Is it obvious which one you ‘should’ use or could you perform the study in more than one way?

1. Investigating the factors responsible for network outages
2. Finding out how to make a website easier to use
3. Analyse how companies use social media for advertising
4. Investigating the Impact of Financial Literacy Programs on Personal Savings Rates
5. Exploring Patterns of Behavior in Online Gaming Communities
6. Studying Leadership Styles in Innovative Companies
7. Exploring Emerging Patterns in Social Media Usage Among Teenagers
8. Agile development will result in fewer bugs than the Waterfall methodology in software projects
9. An encryption algorithm using a 256-bit key will be more secure than one using a 128-bit key

Selecting the methodology

Research method : Qualitative Vs Quantitative



Selecting the methodology

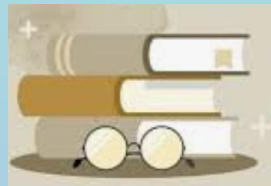
Research method

Qualitative research involves the collection of (soft) data that are open to interpretation, for example, people's opinions which cannot be generalised in numerical terms.

Quantitative research – research that produces statistics (hard data)

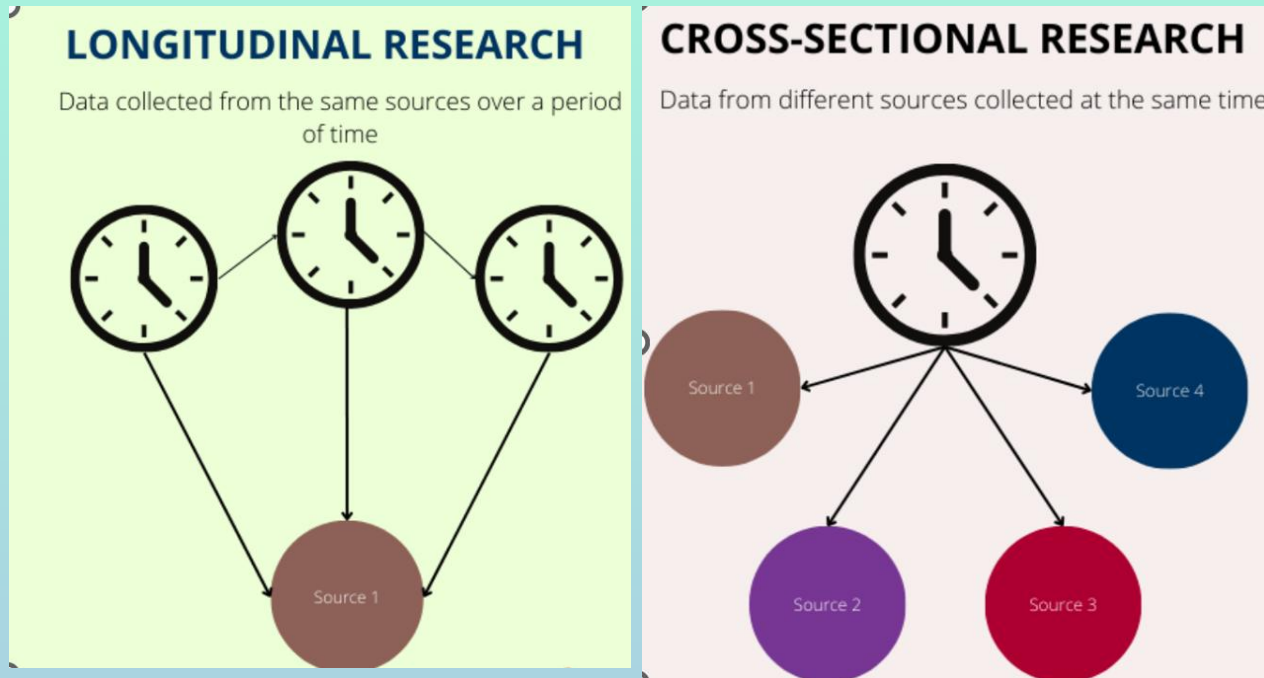
Selecting the methodology

Data: Qualitative Vs Quantitative



Selecting the methodology

Time Horizons – Longitudinal and Cross sectional



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Time Horizons - Longitudinal

Longitudinal research extends over a substantial period of time and involves studying changes over time.

Longitudinal research involves collecting data from the same group of subjects or participants over an extended period.

Example

- A longitudinal study tracking a cohort of children from birth to adulthood to investigate the long-term effects of early childhood interventions on academic achievement, socio-emotional development, and health outcomes.
- Tracking changes in software development practices or technology adoption over time within development teams or organizations
- Technology usage among software developers at a specific point in time

Selecting the methodology

Time Horizons – Cross sectional

Cross-sectional research takes a 'snapshot' of a situation in time
Cross-sectional research involves collecting data from a sample of subjects at a single point in time.

Example

- A cross-sectional study surveying adults of different age groups to examine the prevalence of mental health disorders and identify potential demographic, socioeconomic, or cultural factors associated with higher rates of mental illness.
- Assess current trends and preferences in areas such as programming languages or technology usage among software developers at a specific point in time

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Data collection and analysis

Data analysis involves the systematic examination and interpretation of collected data to derive meaningful insights, identify patterns or trends, and draw conclusions relevant to the research questions or objectives.

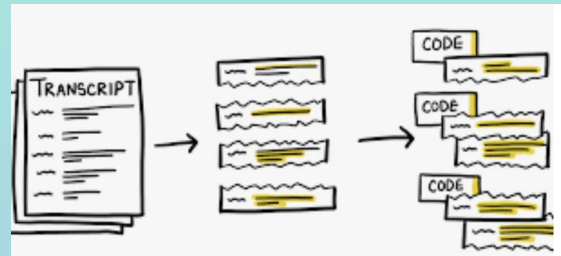
Data Cleaning: Raw data may need to be cleaned and organized to remove errors, inconsistencies, or missing values that could compromise the analysis.

Statistical Analysis: Quantitative data may be analyzed using statistical techniques such as descriptive statistics, inferential statistics (e.g., t-tests, ANOVA, regression analysis), or multivariate analysis to test hypotheses, identify relationships, or make predictions.



Data collection and analysis

Qualitative Analysis: Qualitative data may be analyzed using techniques such as thematic analysis, content analysis, or grounded theory to identify patterns, themes, or categories within the data and generate explanations or theories.



Interpretation: Researchers interpret the findings of the data analysis in light of the research questions, existing literature, and theoretical frameworks. They draw conclusions, make recommendations, and discuss the implications of the findings for theory, practice, or policy

Selecting the methodology

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Philosophy	Positivism				Interpretivism		
Approach	Deductive				Inductive		
Strategies	Experiment	Software Development	Document Review	Action Research	Ethnography	Case Study	Survey

Selecting the methodology

- Selecting

Research Method	Research methodology
It implies the methods employed by the researcher to conduct research	It is the way to systematically solve the research problem
Behaviour and instrument used in the selection and construction of the research technique	Science of understanding how research is performed methodically
Carrying out experiments, tests, surveys, etc.,	Study different technique which can be utilised in the performance of the experiment, test, survey etc.
Different investigation techniques	Entire strategy towards the achievement of the objective
To discover solutions of the research problems	To apply correct procedure as to determine solutions.

Reference

[1]. M. Saunders, P. Lewis, and A. Thornhill, Research Methods for Business Students, 5th ed. Harlow, U.K.: Pearson Education, 2009.