NATIONAL OPEN UNIVERSITY OF NIGERIA

FACULTY OF SCIENCES

COURSE CODE: - CIT 902

COURSE TITLE:-
ICT RESEARCH METHODOLOGY AND STATISTICS

COURSE GUIDE

CIT 902
ICT RESEARCH METHODOLOGY AND STATISTICS

COURSE TEAM

Course Developer/Writer — Dr Kenneth Ikechukwu Nkuma-Udah
Federal University of Technology, Owerri

Content Editor — Prof. Virgy Ejiofor
Nmamdi Azikiwe University, Awka

Course Material Coordination — Dr. Vivian Nwaocha,
Dr. Greg Onwodi &
Dr. Francis B. Osang
Computer Science Department
National Open University of Nigeria

NATIONAL OPEN UNIVERSITY OF NIGERIA

National Open University of Nigeria
Headquarters

Plot 91, Cadastral Zone, Nnamdi Azikiwe Expressway, Jabi – Abuja,

Nigeria

Lagos Office
14/16 Ahmadu Bello Way
Victoria Island
Lagos

e-mail: centralinfo@nou.edu.ng
URL: www.nou.edu.ng

Published by
National Open University of Nigeria

Printed 2020

ISBN:

CONTENTS **PAGE**

Introduction

The course, ICT Research Methodology and Statistics, is a core course for students studying towards acquiring the Doctor of Philosophy in the Department of Computer Science. In this course we will study about Information and Communication Technology

Research Methodology as an important aspect of Research and Development of the personnel involved. Various aspects of ICT Research Methodology with their Statistics are discussed in this course.

The overall aim of this course is to equip you with the techniques of doing research in the field of ICT and the larger computer science discipline.

In structuring this course, we commence with a general introduction of ICT Research Methodology and Statistics and move to ICT Research Tools and Techniques, then zoom into ICT Research Methodology, and finally to the Ethical Issues in ICT Research..

.

There are four modules in this course, module 1 consists of two units of topics; module 2 consists of three units of topics; module 3 consists of three units; and module 4, three units. You are expected to complete each unit of topic in 3 hours. The four modules and their units are listed below.

What You Will Learn in this Course

The overall aims and objectives of this course provide guidance on what you should be achieving in the course of your studies. Each unit also has its own unit objectives which state specifically what you should be achieving in the corresponding unit. To evaluate your progress continuously, you are expected to refer to the overall course aims and objectives as well as the corresponding unit objectives upon the completion of each.

Course Aims

The overall aims and objectives of this course will help you to:

1. Develop your knowledge and understanding of the concept of ICT Research Methodology and Statistics
2. Build up your capacity on ICT Research and their Methodology
3. Develop your competence in ICT Research and Statistics

Course Objectives

Upon completion of the course, you should be able to:

1. Describe the basic concepts of ICT Research
2. Explain the various types of ICT Research Tools and Techniques
3. Organise and do ICT Research
4. Understand the Ethical Issues involved in ICT Research

Working through this Course

We designed this course in a systematic way, so you need to work through it from Module one, Unit 1 through to Module four, Unit 3. This will enable you appreciate the course better.

Course Materials
Basically, we made use of textbooks and online materials. You are expected to search for more literature and web references for further understanding. Each unit has references and web references that were used to develop them.

Online Materials
You should be able to refer to the web sites provided for all the online reference materials required in this course.

The website is designed to integrate with the print-based course materials. The structure follows the structure of the units and all the reading and activity numbers are the same in both media.

Study Units

Module 1 Introduction to ICT Research Methodology and Statistics
Unit 1 What is ICT Research?
Unit 2 Research Methods Vs Research Methodology

Module 2 ICT Research Tools and Techniques
Unit 1 Introduction to Quantitative and Qualitative Data Collection
Unit 2 Design of Data Collection Tools and Techniques
Unit 3 Modeling, Simulation, Algorithm, Conceptualization, Abstraction and Data Analysis Techniques.

Module 3 ICT Research Methods
Unit 1 ICT Research Life Cycle
Unit 2 Methods and Approaches Applicable to the Conduct of ICT Research.
Unit 3 Design and Communication of Research Proposals for ICT Projects

Module 4 ICT / Software Research Methodologies
Unit 1 Introduction to ICT / Software Research Methodologies
Unit 2 Traditional ICT / Software Research Methodologies
Unit 3 Other Related (Non-Traditional) ICT / Software Research Methodologies

Module 5 Ethical Issues in ICT Research
Unit 1 Ethical Issues Involved in Planning, Conducting and Reporting of ICT Research
Unit 2 Application of Concepts and Critical Engagement with Issues Relating to Personal Research Needs
Unit 3 Assessment Items Related to Personal Research Topic

From the preceding, the content of the course can be divided into four major blocks:

1. Overview of ICT Research Methodology and Statistics
2. ICT Research Tools and Techniques

3. ICT Research Methodology
4. Ethical Issues in ICT Research

Module one gives an overview of Research Methodology and Statistics
Module Two explains the basic tools and techniques of ICT Research.
Module Three describes ICT Research Methodology
Module Four discusses the Ethical Issues involved in in ICT Research.

Equipment
In order to get the most from this course, it is essential that you have in hand a computer system, which has internet access, with various computer storage devices and accessories. In addition to this you are expected to have access to a University library and /or a virtual library.

Recommended System Specifications:

Processor
2.0 GHZ Intel compatible processor
1GB RAM
80 GB hard drive with 5 GB free disk
CD-RW drive.
3.5" Floppy Disk Drive or USB Flash Drive
TCP/IP (installed)

Operating System
Windows XP Professional (Service Pack
Microsoft office 2007
Norton Antivirus

Monitor*
19-inch
1024 X 768 resolution
16-bit high color
*Non Standard resolutions (for example, some laptops) are not supported.

Hardware
Open Serial Port (for scanner)
120W Speakers
Mouse + pad

Windows keyboard
Laser printer

Hardware is constantly changing and improving, causing older technology to become obsolete. An investment in newer, more efficient technology will more than pay for itself in improved performance results.

If your system does not meet the recommended specifications, you may experience considerably slower processing when working in the application.

Systems that exceed the recommended specifications will provide better handling of database files and faster processing time, thereby significantly increasing your productivity.

Assessment
The course, ICT Research Methodology and Statistics entails attending a three-hour final examination which contributes 70% to your final grading. The final examination covers materials from all parts of the course with a style similar to the Tutor-Marked Assignments (TMA).

The examination aims at testing your ability to apply the knowledge you have learned throughout the course, rather than your ability to memorize the materials. In preparing for the examination, it is essential that you receive the activities and Tutor-Marked Assignments you have completed in each unit. The other 30% will account for all the TMA's at the end of each unit.

Tutor-Marked Assignment
About 20 hours of tutorials will be provided in support of this course. You will be notified of the dates, time and location for these tutorials, together with the name and phone number of your tutor as soon as you are allotted a tutorial group.

Your tutor will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter and provide assistance to you during the course. You must mail your TMAs to your tutor well before the due date (at least two working days are required). They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact your tutor by phone, e-mail if you need help. The following might be circumstances in which you would find help necessary. You can also contact your tutor if:

- you do not understand any part of the study units or the assigned readings

- you have difficulty with the TMAs
- you have a question or problem with your tutor's comments on an assignment or with the grading of an assignment

You should try your best to attend tutorials, since it is the only opportunity to have an interaction with your tutor and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain maximum benefit from the course tutorials, you are advised to prepare a list of questions before attending the tutorial. You will learn a lot from participating in discussions actively.

Course Overview

This section proposes the number of weeks that you are expected to spend on the four modules comprising of 11 units and the assignments that follow each of the unit. We recommend that each unit with its associated TMA is completed in one week, bringing your study period to a maximum of 11 weeks.

How to Get the Most from this Course

In order for you to learn various concepts in this course, it is essential to practice. Independent activities and case activities which are based on a particular scenario are presented in the units. The activities include open questions to promote discussion on the relevant topics, questions with standard answers and program demonstrations on the concepts.

You may try to delve into each unit adopting the following steps:

1. read the study unit
2. read the textbook, printed or online references
3. perform the activities
4. participate in group discussions
5. complete the tutor-marked assignments
6. participate in online discussions

This course makes intensive use of materials on the world-wide web. Specific web address will be given for your reference. There are also optional readings in the units. You may wish to read these to extend your knowledge beyond the required materials. They will not be assessed.

Summary

The course, ICT Research Methodology and Statistics is intended to develop your understanding of the concepts of ICT Research, thus enabling you acquire skills in ICT Research Methodology and Statistics involved. This course also provides you with practical knowledge and hands-on experience in ICT Research.

We hope that you will find the course enlightening and that you will find it both interesting and useful. In the longer term, we hope you will get acquainted with the National Open University of Nigeria and we wish you every success in your future.

NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF SCIENCE AND TECHNOLOGY

COURSE CODE:- CIT 902

COURSE TITLE:-
ICT RESEARCH METHODOLOGY AND STATISTICS

NATIONAL OPEN UNIVERSITY OF NIGERIA
National Open University of Nigeria
Headquarters
No. 5 Dar es Salaam Street
Off Aminu Kano Crescent
Wuse II, Abuja
Nigeria

Lagos Office
14/16 Ahmadu Bello Way
Victoria Island
Lagos

e-mail: centralinfo@nou.edu.ng
URL: www.nou.edu.ng

Published by
National Open University of Nigeria

Printed 2018

ISBN:

CONTENTS **PAGE**

iv

Module 1: Introduction to ICT Research Methodology and Statistics

UNIT 1 WHAT IS ICT RESEARCH

CONTENTS

1.0 INTRODUCTION

In this unit you will consider what research is and then what ICT research is. You will also learn the applications of ICT research

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what ICT Research is
- describe the applications of ICT research

3.0 MAIN CONTENT

3.1 What is ICT Research?

The word Research is derived from the root word *search*, which means to try to find something by looking or otherwise seeking carefully and thoroughly; to examine something thoroughly; to look into or over something carefully – to look for information.

Therefore *Research* can be said to mean to search again; to try to find something by looking further; to seek again more carefully and thoroughly; to examine further – to look for further information. Scientifically, Research is a methodical investigation into a subject in order to discover/establish more facts or information. It is the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions.

Research can be carried in virtually every field of endeavour including: Science, Engineering and Technology, Information and Communication Technology, Humanities, Art, Economics, Sociology, Business, Marketing, etc. The field of interest here is Information and Communication Technology (ICT) research.

Now *information and communication technology, ICT*, is an amalgamation of two terms: information technology and communication technology. The term is generally accepted to mean all devices, networking components, applications and systems that when combined allow people, systems, and organizations (i.e., businesses, nonprofit agencies, governments and criminal enterprises) to interact in the digital world. It underpins innovation and competitiveness across private and public sectors and enables scientific progress in all disciplines.

ICT provides the core enabling technologies for harnessing all other subject area, including science, engineering, technology, and even arts. It also provides the tools to organize vast amounts of data that are obtained experimentally and empirically, as well as enables the generation, through simulations, of massive amounts of data that drive a deeper insight into the behavior of systems that exist theoretically or are entirely abstract. So it is clear that ICT is a discipline where all of the other disciplines meet for techniques and expertise requirements that they hold in common. Modern society not only depends upon ICT for its survival, ICT has proven to be the pivot for research in all disciplines, since they increasingly turns to it for their livelihood, convenience and pleasure.

ICT Research can therefore be said to be the systematic investigation into and study of materials and sources in all sector of human endeavour using the instruments of information and communication technology in order to establish facts, reach new conclusions and produce new products.

3.2 Applications of ICT Research

Strictly speaking, ICT Research is organized in three broad specializations: mobile communication systems; system development and security; and multimedia. However, ICTs is known to permeate all areas of endeavour and used as a powerful driver of innovation, growth and productivity globally. New knowledge and applications created in continual ICT research and development (R&D) activities are critical factors in meeting all the challenges and risks connected with eBusiness implementation and information society development.

As ICT Research moves from Basic Research until it finally enters market uptake, it passes through series of stages. The stages of ICT Research include: Basic Research >Technology R&D>Demonstration>Prototyping>Large scale validation>Pilots>Market Uptake.

However, as a generic technology, ICT's influence in research can be categorized into three broad ICT-driven areas of endeavour, vis:

- 1) Excellent Science: Future and emerging technologies; research infrastructure
- 2) Industrial leadership: Leadership in enabling & industrial technologies; Innovation in SMEs
- 3) Societal Challenges: • Health, demographic change & wellbeing; Food security, sustainable agriculture & the bio-based economy; Secure, clean & efficient energy; Smart, green & integrated transport; Climate action, resource efficiency, & raw materials; Inclusive, innovative & reflective societies; Secure societies

2 **Conclusion**

In this unit you have been introduced to ICT Research. You have also been introduced to the Applications of ICT Research.

5.0 Summary

In this unit, ICT Research include all the scientific and systematic investigation involving the ICT. As ICT Research moves from Basic Research into market uptake, it influences three broad categories of ICT-driven areas of endeavour: Excellent Science, Industrial leadership and Societal Challenges.

6.0 Tutor-Marked Assignment

1. Define ICT Research
2. Describe the Applications of ICT Research.

7.0 References/Further Readings

1. European Commission, (2016): A Guide to ICT-related activities in WP 2016-17 at <http://www.db.dk/bh/publ_uk.htm>
2. Saleem A., Shabana T.S.Z. and Batcha M.S., (2013): Application and Uses of Information communication Technology (ICT) in Academic Libraries: An Overview, International Journal of Library Science, **2,** 3, pp 49-52.

CONTENTS

1.0 INTRODUCTION

In this unit you will consider what research methods and research methodology are. You will also learn the major differences between research methods and research methodology.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what research methods are
- explain the meaning of research methodology
- discuss the differences between research method and research methodology.

3.0 MAIN CONTENT

3.1 Research Methods

A Research Method is the specific technique, tool or procedure applied to achieve a given research objective. Here the research design is laid out. It is what a researcher does in order to collect his data and carry out his investigations. It depends on the question that the researcher wishes to answer, and the philosophy that underpins his view of research. Research method is a step in a Research process. It is also one of the four main features of research design. The other three features of research design are ontology, epistemology and methodology.

Research method pertains to all those methods, which a researcher employs to undertake research process, to solve the given problem. It comprises of methods of performing the research, including survey, case study, interview, questionnaire, observation, etc. These are the approaches, which help in collecting data and conducting research, in order to achieve specific objectives such as theory testing or development. All the instruments and behaviour, used at various levels of the research activity are included here. These research activities include making observations, data collection, data processing, drawing inferences, decision making, etc. Examples of research methods are surveys, interviews, experiments, observation, case studies, questionnaires, statistical approaches, etc

Research methods are categorized into three:

- **1st Category**: The methods relating to data collection are covered here. Such methods are used when the existing data are not sufficient, to reach the solution.
- **2nd Category:** Incorporates the processes of analyzing data, i.e. to identify patterns and establish a relationship between data and unknowns.
- **3rd Category**: Comprises of the methods which are used to check the accuracy of the results obtained.

A research method shows how the research study is designed. Its choice depends on:

- Research Questions
- Research Goals
- Researcher Beliefs and Values
- Researcher Skills
- Time and Funds

The research method to be used in a study may be:

- Qualitative – descriptive in nature eg. case study, participatory action research , data gathering etc
- Quantitative – involves experiments/measurements, observations or surveys
- Mixed Methods - drawn from both qualitative and quantitative methods

3.2 Research Methodology

Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic. In a research paper, the methodology section allows the reader to critically evaluate a study's overall validity and reliability. The methodology section answers two main questions: How was the data collected or generated? How was it analyzed? The methodology may include publication research, interviews, surveys and other research techniques, and could include both present and historical information.

Research methodology is a way to systematically solve the research problem. It can be defined as a science of studying how research is done scientifically. Research Methodology, as its name suggest is the study of methods, so as to solve the research problem. It is the science of learning the way research should be performed systematically. It refers to the rigorous analysis of the methods applied in the stream of research, to ensure that the conclusions drawn are valid, reliable and credible too.

The researcher is expected to know both the research methods/techniques and the methodology. They not only need to know how to develop certain indices or tests, how to calculate the mean, the mode, the median or the standard deviation or chi-square, how to apply particular research techniques, but they also need to know which of these methods or techniques, are relevant and which are not, and what would they mean and indicate and why. Researchers also need to understand the assumptions underlying various techniques and they need to know the criteria by which they can decide that certain techniques and procedures will be applicable to certain problems and others will not.

That is to say that it is necessary for the researcher to design his methodology for his problem since the methodology may differ from problem to problem. For example, an automobile engineer, who designs a car, has to consciously evaluate the basis of his decisions, i.e., he has to evaluate why and on what basis he selects particular shape, colour and brand of cars, uses particular materials and not others and so on. Similarly, in research the scientist has to expose the research decisions to evaluation before they are implemented. He has to specify very clearly and precisely what decisions he selects and why he selects them so that they can be evaluated by others also.

3.3 Research Methods Vs Research Methodology

To conduct his research, the researcher uses *research methods*, during the course of conducting research. Many times, the research methods are confused with *research methodology*, which implies the scientific analysis of the research methods, so as to find a solution to the problem at hand. Research methods are the strategies, tools, and techniques used by the researcher to collect the relevant evidence needed to create theories. Consequently, these research methods need to be credible, valid, and reliable. This is accomplished by writing a sound methodology, which consists of a systematic and theoretical analysis of the above research methods. A methodology allows the researcher to evaluate and validate the rigour of the study and methods used to obtain the new information. Research methods constitute only one component of the multidimensional research methodology.

In order to clarify the differences between research method and research methodology, we shall use a comparison chart to look at them with respect to their meaning; what each is; what they encompass; what they comprise of; and their objective (Table 1.1).

Table 1.1: Differences Between Research Method and Research Methodology using their Basis of Comparison

BASIS OF COMPARISON	RESEARCH METHOD	RESEARCH METHODOLOGY
Meaning	Research Method implies the methods employed by the researcher to conduct research.	Research methodology signifies way to efficiently solving research problems.
What is it?	Behavior and instrument used in the selection and construction of the research technique.	Science of understanding, how research is performed methodically.
Encompasses	Carrying out experiment, test, surveys and so on.	Study different techniques which can be utilized in the performance of experiment, test, surveys etc.
Comprise of	Different investigation techniques.	Entire strategy towards achievement of objective.

BASIS OF COMPARISON	RESEARCH METHOD	RESEARCH METHODOLOGY
Objective	To discover solution to research problem.	To apply correct procedures so as to determine solutions.

4.0 Conclusion

In this unit you have been introduced to research methods and research methodology. You have also been acquainted with the differences between research methods and research methodology.

5.0 Summary

In this unit, the researcher uses research methods, during the course of conducting research. However, the research methods are often confused with research methodology, which implies the scientific analysis of the research methods, so as to find a solution to the problem at hand.

6.0 Tutor-Marked Assignment

1. Define Research Methods and Research Methodology
2. In a tabular format, differentiate between Research Methods and Research Methodology.

7.0 References/Further Readings

1. Kothari C.R. (2004), Research Methodology: Methods & Techniques, New Age International (P) Ltd., Publishers Accessed August 01, 2018 @ http://www.modares.ac.ir/uploads/ Agr.Oth.Lib.17.pdf
2. Key Differences, (2016), Difference between Research Method and Research Methodology. Accessed on 31st August, 2018 @ https://keydifferences.com/difference-between-research-method-and-research-methodology.html

Module 2: ICT Research Tools and Techniques

Unit 1 Introduction to Quantitative and Qualitative Data Collection
Unit 2 Design of Data Collection Tools and Techniques
Unit 3 Modeling, Simulation, Algorithm, Conceptualization, Abstraction and Data Analysis Techniques.

UNIT 1 INTRODUCTION TO QUANTITATIVE AND QUALITATIVE DATA COLLECTION

CONTENTS

1.0 INTRODUCTION

In this unit you will consider what Quantitative and Qualitative Data are. You will also learn what Quantitative and Qualitative Data Collection are all about and the differences between Quantitative and Qualitative Data Collection.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what Quantitative and Qualitative Data are
- describe what Quantitative and Qualitative Data Collection mean
- discuss the differences between Quantitative and Qualitative Data Collection

3.0 MAIN CONTENT

Data are a set of raw facts and figures without meaning or context. However, it undergoes processing, where it will be organized, structured and given context through interpretation and analysis. So, processing gives data meaning, effectively turning it into ***information***. Collectively, all information makes up bodies of ***knowledge***.

Without data, there won't be any information. Therefore, no matter how data may seem random and useless, it is actually considered to be the most important and basic unit of any information structure or body of knowledge.

8 are two main types of data that can be collected: quantitative and qualitative data. Both types of data are valid types of measurement, and both are used in education or the academic world. Only quantitative data can be analyzed statistically, and thus more rigorous assessments of this data are possible.

3.1 Overview of Quantitative Data

Quantitative data are data that deal with quantities, values or numbers, making them measurable. Thus, they are usually expressed in numerical form, such as length, size, amount, price, and even duration. Quantitative data in statistics is also known as categorical data. The data can be arranged categorically based on attributes and properties of a thing or a phenomenon. The use of statistics to generate and subsequently analyze this type of data adds credibility to it, so that quantitative data is overall seen as more reliable and objective.

Therefore, quantitative data are data that can be quantified and verified, and is amenable to statistical manipulation. Quantitative data are the data used for quantitative methods and research. Examples of quantitative data are scores on achievement tests, number of hours of study, or weight of a subject. These data may be represented by ordinal, interval or ratio scales and lend themselves to most statistical manipulation.

3.2 Overview of Qualitative Data

Qualitative data are data that approximates or characterizes but do not measure the attributes, characteristics, properties, etc., of a thing or phenomenon. Such data cannot be expressed as a number, unlike quantitative data. This type of data is descriptive in nature. It represents nominal scales such as gender, socio-economic status, etc. Religious preference are usually considered to be qualitative data.

Qualitative data are important in determining the particular frequency of traits or characteristics. It allows the statistician or the researchers to form parameters through which larger data sets can be observed. Qualitative data provides the means by which observers can quantify the world around them.

3.3 Quantitative and Qualitative Data Collection

Data collection is described as the “process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer queries, stated research questions, test hypotheses, and evaluate outcomes.”

Apart from the ICT field, data play a very important role, serving as the respective starting points in many other fields like in business, marketing, humanities, physical sciences, social sciences, or other fields of study or discipline,. That is why, in all of these processes that involve the usage of information and knowledge, one of the very first steps is data collection.

Depending on the discipline or field, the nature of the information being sought, and the objective or goal of users, the methods of data collection will vary. The approach to applying the

methods may also vary, customized to suit the purpose and prevailing circumstances, without compromising the integrity, accuracy and reliability of the data.
Quantitative and qualitative data are the two main types of data that users find themselves working with – and having to collect. In most cases, these two data types are used as preferences in choosing the method or tool to be used in data collection. Consequently, data collection methods are classified into two, based on these types of data. These are: the quantitative data collection methods and the qualitative data collection methods.

Importance of Data Collection include the following:
1. Data collection aids in the search for answers and resolutions.
2. It facilitates and improves decision-making processes, and the quality of the decisions made.
3. Data collection improves quality of expected results or output.

3.4 Differences between Quantitative and Qualitative Data Collection

The differences between quantitative and qualitative data collection is summarized in Table 2.1 below.

Table 2.1: Differences Between Quantitative and Qualitative Data Collection using their Items of Differentiation

ITEM OF DIFFERENTIATION	QUANTITATIVE DATA COLLECTION	QUALITATIVE DATA COLLECTION
Type of data	Numerical and countable data.	Descriptive and measurable data
Method	Data that can be numerically counted or expressed is collected.	Data which characteristics, attributes, properties, qualities is described, is collected.
Research	It lacks description and explanation thus it is backed by qualitative data. So it uses a combination of qualitative and quantitative methods in research.	Its unreliable, so backed by quantitative data. That is uses a combination of qualitative and quantitative methods in research.
Examples	Deals with measurements like height, length, volume, area, humidity, temperature, etc.	Deals with characteristics, attributes, properties like color of a house, the texture of a shoe.
Summary	Quantitative data is generalisable, deductive, objective and deal in numbers	Qualitative data is non generalisable, inductive, subjective and deal in words

4.0 Conclusion

In this unit you have been introduced to quantitative and qualitative data. You also learnt about what quantitative and qualitative data mean and then the differences between quantitative and qualitative data collection.

10

5.0 Summary

In this unit, data are a set of raw facts and figures without meaning or context. Without data, there won't be any information. There are two main types of data that can be collected: quantitative and qualitative data.

6.0 Tutor-Marked Assignment

1. Define quantitative and qualitative data
2. Itemize what qualitative and qualitative data collection mean
3. Differentiate between Quantitative and Qualitative data

7.0 References/Further Readings

1. Defranzo S.E. (2011). What's the difference between qualitative and quantitative research? SnapSurveys @ https://www.snapsurveys.com/blog/qualitative-vs-quantitative-research/
2. Bhat A. (2018). Qualitative Data - Definition, Types, Analysis and Examples. QuestionPro @ https://www.questionpro.com/blog/qualitative-data/
3. Anastasia (2017). Overview of Qualitative and Quantitative Data Collection Methods. Cleverism @ https://www.cleverism.com/qualitative-and-quantitative-data-collection-methods/

UNIT 2 DESIGN OF DATA COLLECTION TOOLS AND TECHNIQUES

CONTENTS

1.0 INTRODUCTION

In this unit you will consider what data collection tools and techniques are. You will also learn the steps in designing data collection tools and techniques.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what data collection tools and techniques are
- describe steps in designing data collection tools and techniques

3.0 MAIN CONTENT

3.1 Data Collection Tools and Techniques

Data collection tools and techniques are the devices and methods used in data collection. Data collection itself is the process of gathering and measuring information on targeted variables in an established systematic fashion, which then enables one to answer relevant questions and evaluate outcomes. Data collection is a component of research in all fields of study such as the sciences, engineering, technology, humanities and business. While the techniques vary by discipline, the emphasis on ensuring accurate and honest collection remains the same. The goal for all data collection is to capture quality evidence that allows analysis to lead to the formulation of convincing and credible answers to the questions that have been posed.

The data collection tools and techniques shall here be categorized into two according to the type of data – quantitative or qualitative – being collected. It would be noticed that some techniques fall under both categories, which means that they can be used in gathering both types of data.

3.1.1 Quantitative Data Collection Tools and Techniques

Data can be readily quantified and generated into numerical form, which will then be converted and processed into useful information mathematically. The result is often in the form of statistics

that is meaningful and, therefore, useful. You will see that unlike qualitative methods, these quantitative techniques usually make use of larger sample sizes because its measurable nature makes that possible and easier.

12 of the common quantitative data collection tools and techniques include:

- Quantitative Surveys
- Interviews
- Quantitative Observation
- Experiments

Quantitative Surveys

Unlike the open-ended questions asked in qualitative questionnaires, quantitative paper surveys pose closed questions, with the answer options provided. The respondents will only have to choose their answer among the choices provided on the questionnaire. Advantages include that it is ideal for use when surveying large numbers of respondents and the standardized nature of questionnaires enable researchers to make generalizations out of the results. However, the disadvantages include the fact that the closed questions can be very limiting to the respondents, since it is possible that his actual answer to the question may not be in the list of options provided on the questionnaire. Again, while data analysis is still possible, it will be restricted by the lack of details.

Interviews

Personal one-on-one interviews may also be used for gathering quantitative data. In collecting quantitative data, the interview is more structured than when gathering qualitative data, comprised of a prepared set of standard questions. Interviews can take the following forms:

I. Face-to-face interviews: Allows the researcher to make clarifications on any answer given by the interviewee. However, this can be quite a challenge when dealing with a large sample size or group of interviewees as it can take a lot of time and money.

II. Telephone, Video and/or online, web-based interviews, such as Skype: data collection may be cast wider, since there is no need to travel through distances to get the data. However, quality of the data may be questionable, especially in terms of impartiality.

III. Computer-assisted interviews: This Computer-Assisted Personal Interviewing saves a lot of time and other resources in converting them into information later on. However, the use of computers, databases and related devices and technologies are very costly.

Quantitative Observation

Data may be collected through systematic observation. Examples, counting the number of users present and counting the number of services being used within a designated vicinity. When quantitative data are being sought, the approach is naturalistic observation, which mostly involves using the senses and keen observation skills to get data about the “what”, and not really about the “why” and “how”. The technique is quite a simple and cheap way of collecting data. However, the problem is that senses can fail like in personal bias.

Experiments

A typical example of experiments is a clinical trial. It is considered to be a form of experiment used to collect quantitative data. Experiments involve manipulation of an independent variable, while maintaining varying degrees of control over other variables, most likely the dependent ones. Usually, this is employed to obtain data that will be used later on for analysis of relationships and correlations.

Major types of experiments include:

- Laboratory experiments -A typical scientific experiment setup, taking place within a confined, closed and controlled environment (the laboratory), with the data collector being able to have strict control over all the variables.
- Field experiments - Takes place in a natural environment, "on field" where, although the data collector may not be in full control of the variables, he is still able to do so up to a certain extent.
- Natural experiments -Here, the data collector has no control over the independent variable whatsoever, which means it cannot be manipulated. Therefore, what can only be done is to gather data by letting the independent variable occur naturally, and observe its effects.

3.1.2 Qualitative Data Collection Tools and Techniques

Qualitative data collection tools and techniques are exploratory in nature. They are mainly concerned at gaining insights and understanding on underlying reasons and motivations, so they tend to dig deeper. Since they cannot be quantified, measurability becomes an issue, leading to the preference for tools and techniques that are largely unstructured or, in some cases, may be structured but only to a very small, limited extent.

Generally, qualitative techniques are time-consuming and expensive to conduct, and so researchers try to lower the costs incurred by decreasing the sample size or number of respondents. Some of the common qualitative data collection tools and techniques include:

- Face-to-Face Personal Interviews
- Qualitative Surveys
- Focus Groups
- Documental Revision
- Observation
- Longitudinal studies
- Case Studies

Face-to-Face Personal Interviews

This is considered to be the most common data collection instrument for qualitative research, primarily because of its personal approach. The interviewer will collect data directly from the subject (the interviewee), on a one-on-one and face-to-face interaction. This is ideal for when data to be obtained must be highly personalized.

The interview may be informal and unstructured – even conversational – as if taking place between two casual to close friends. The questions asked are mostly unplanned and spontaneous, with the interviewer letting the flow of the interview dictate the next questions to be asked. However, a semi-structured interview can be conducted where the researcher asks the same

series of open-ended questions to all the respondents. Advantages of this type of technique include that it allows the interviewer to probe further, by asking follow-up questions and getting more information in the process and the data will be highly personalized (particularly when using the informal approach). However, this technique is subject to certain limitations, such as language barriers, cultural differences, and geographical distances and the person conducting the interview must have very good interviewing skills in order to elicit responses.

Qualitative Surveys

These can be paper questionnaires or web-based questionnaire.

Paper Questionnaires: Questionnaires often utilize a structure comprised of short questions and, in the case of qualitative questionnaires, they are usually open-ended, with the respondents asked to provide detailed answers, in their own words. It's almost like answering essay questions. Advantages include the fact that since questionnaires are designed to collect standardized data, they are ideal for use in large populations or sample sizes of respondents. Also the high amount of detail provided will aid analysis of data. However, the large number of respondents (and data), combined with the high level and amount of detail provided in the answers, will make data analysis quite tedious and time-consuming.

Web-based questionnaires: This is basically a web-based or internet-based survey, involving a questionnaire uploaded to a site, where the respondents will log into and accomplish electronically. Advantages of this type is that data collection is definitely quicker and cheaper as well as being uncomplicated, since the respondents can be invited to answer the questionnaire by simply sending them an email containing the URL of the site where the online questionnaire is available for answering. However, there is a limitation on the respondents, since the only ones to be able to answer are those who own a computer, have internet connection, and know their way around answering online surveys. Again, the lesser amount of detail provided means the researcher may end up with mostly surface data, and no depth or meaning, especially when the data is processed.

Focus Groups

This is basically an interview technique, but done in a group discussion setting. It's a highly recommended technique, when the object of the data is behaviors and attitudes, particularly in social situations, and resources for one-on-one interviews are limited. The topic that data will be collected about will be presented to the group, and the moderator will open the floor for a debate. Major advantages are the fact that the setup or framework of data being delivered and shared makes it possible to come up with a wide variety of answers; and the data collector may also get highly detailed and descriptive data. A major disadvantage is that the researcher must be highly capable and experienced in controlling these types of interactions since much of the success of the discussion lies in his/her hands..

Documental Revision

This technique involves the use of previously existing and reliable documents and other sources of information as a source of data to be used in a new research or investigation. An example is the use of library books and other references to collect data. Advantages: the researcher will gain better understanding of the field or subject being looked into and taking a look into other

documents or researches as a source will provide a glimpse of the subject being looked into from different perspectives or points of view, allowing comparisons and contrasts to be made. Disadvantage: this relies heavily on the quality of the document that will be used, and the ability of the data collector to choose the right and reliable documents.

Observation

Here, the researcher takes a participatory stance, immersing himself in the setting where his respondents are, and generally taking a look at everything, while taking down notes, taking video and audio recording, photography, etc. The main advantages include the fact that the participatory nature may lead to the researcher getting more reliable information; and that data is more reliable and representative of what is actually happening, since they took place and were observed under normal circumstances. The disadvantages are that the participation may end up influencing the opinions and attitudes of the researcher, so he will end up having difficulty being objective and impartial as soon as the data he is looking for comes in; and that validity may arise due to the risk that the researcher's participation may have an impact on the naturalness of the setting. For instance, the observed may become reactive to the idea of being watched and observed.

Longitudinal studies

This is a research or data collection technique that is performed repeatedly, on the same data sources, over an extended period of time. It is an observational research method that could even cover a span of years and, in some cases, even decades. The goal is to find correlations through an empirical or observational study of subjects with a common trait or characteristic. The advantages include the fact that this is ideal when seeking data meant to establish a variable's pattern over a period of time, particularly over an extended period of time; and as a method to find correlations, it is effective in finding connections and relationships of cause and effect. However, its disadvantages are that the long period may become a setback; and over the extended period, attitudes and opinions of the subjects are likely to change.

Case Studies

In this qualitative technique, data is gathered by taking a close look and an in-depth analysis of a "case study" or "case studies" – the unit or units of research that may be an individual, a group of individuals, or an entire organization. This methodology's versatility is demonstrated in how it can be used to analyze both simple and complex subjects. Advantages are that it is flexible and versatile, analyzing both simple and complex units and occurrence, even over a long period of time; and case studies provide in-depth and detailed information because of how it captures as many variables as it can. However, reliability of the data may be put at risk when the case study or studies chosen are not representative of the sample or population.

3.2 Steps in Designing Data Collection Tools

Choosing appropriate data collection tool (surveys, questionnaires, observation etc.) is a vital part of conducting good quality empirical research or evaluation. There are several crucial steps that can be used to design data collection tools and techniques. Incorporating these steps into a data collection plan will improve the likelihood that the data collected are genuine and can be used to support the ensuing analysis.

This is important because too often researchers fall vulnerable to 'availability bias' and simply select whatever they can get their hands on, or they default to using data collection tool that have commonly been used in the past. Poor tool or technique design and selection add error to one's research.

16 nportant steps in designing and selecting data collection tool are as follows:

- Check the Appropriateness of the Data Collection Tool
- March the tool with the Program (or Research) Objectives
- Look at the Sensitivity of the Data Collection Tool
- How Specific is the Data Collection Tool?
- Verify the Reliability and Validity of the Data Collection Tool
- Are there Ethical/Educational Issues

3.2.1: Check the Appropriateness of the Data Collection Tool

The first step to take to design a data collection tool is ask yourself: Is the instrument appropriate for the participants?…in terms of length & complexity? In outdoor and experience-based research programs, data collection tools are often administered in field settings (e.g. in the bush, on board a boat, in various weather conditions), on multiple occasions (e.g. pre-program, first day of program, last day of program and post-program follow-up) and to a wide range of participants (e.g. people with learning disabilities, people without English as their first language, school children, corporate managers).

Therefore, the shorter and simpler a data collection tool (reliability and validity aside), the greater the tool's potential applicability. The aim should be to design a tool/instrument which would provide a maximum amount and type of unique information in as short a time as possible (i.e. a maximum of about ten minutes).

3.2.2: March the tool with the Program (or Research) Objectives

Is the data collection tool relevant to the Research Program aim. Generally, a major aim of many outdoor experiential research programs is to facilitate individuals personal development in a broad range of life skills (e.g. self-confidence, initiative, communication skills, etc.), although different researches may have more specific aims such as the development of teamwork and leadership skills. Ideally, the tool is expected to encompass a wide range of life proficiency domains relevant to general and specific research aims, so as to allow for within and between research program comparison of different program outcomes.

3.2.3: Look at the Sensitivity of the Data Collection Tool

Has the data collection tool been built with a view to being used for assessing what you want to measure? Or are there changes you need to make to adapt the tool? The scoring system is an important aspect of a tool's sensitivity to change. For instance, in a questionnaire, a dichotomous (yes/no) scoring does not provide much sensitivity. On the other hand, a large range can reduce the tool's reliability. A balance needs to be reached between sensitivity to change and reliability. Despite being a critical issue, a search of the literature may revealed little research.

3.2.4: How Specific is the Data Collection Tool?

The greater the specificity of a measure, the more likely it is to predict actual performance. The data collection tool should be specific to the data its required to collect to yield much result. For instance, in a questionnaire, it is desirable that the wording of the items and the response scale tends to produce responses from participants that leave room for detecting shifts in self-perceptions either up or down -- hence the means need to be examined during the development.

3.2.5: Verify the Reliability and Validity of the Data Collection Tool

Has the reliability and validity of the data collection tool been well established via peer-reviewed mechanism? Do you understand the strengths and limitations of the tool? Another issue to be considered in designing a data collection tool for measuring change is test-retest correlations. The test-retest correlations give an indication of the stability of items and scales. If these correlations are low, then participants' responses to the item or scale may change for reasons other than those that can be attributed to an intervention experience.

3.2.6: Are there Ethical/Educational Issues

If possible, can the data collection tool be used not only for the interests of the researcher, but also in the education/development of participants? For example, a self-assessment tool could be used not only for research purposes but also to lead onto a goal-setting and feedback session with participants. The methods used to facilitate personal change during outdoor experiential research programs include providing opportunities for self-assessment, goal-setting, and feedback on personal progress. A tool which can be used to facilitate the processes of self-examination, goal-setting and feedback would give it added value.

4.0 Conclusion

In this unit you have been introduced to data collection tools and techniques. You also learnt the steps in designing data collection tools and techniques.

5.0 Summary

In this unit, data collection tools and techniques are the devices and methods used in data collection. Data collection is a component of research in all fields of study such as the sciences, engineering, technology, humanities and business. While the techniques vary by discipline, the emphasis is on ensuring accurate and honest collection remains the same.

6.0 Tutor-Marked Assignment

1. Define Data Collection Tools
2. List and briefly discuss the Data Collection Tools
3. What are the steps in designing data collection tools and techniques.

7.0 References/Further Readings

1. Data Collection Tools, in Action-Based Research, October, 2013 at <https://alaworkshopdata.wordpress.com/data-collection-tools/>
2. Science Struck (2018). Types of Data and 7 Major Techniques of Data Collection at <https://sciencestruck.com/data-collection-techniques>
3. Wikipadia (2018), Data Collection at <https://en.wikipedia.org/wiki/Data_collection>

4. James Neill, (2004),How to Choose Tools, Instruments, & Questionnaires for Intervention Research & Evaluation at <http://www.wilderdom.com/tools/ToolsHowChoose.html>

18

UNIT 3 MODELING, SIMULATION, ALGORITHM, CONCEPTUALIZATION, ABSTRACTION AND DATA ANALYSIS TECHNIQUES.

CONTENTS

1.0 INTRODUCTION

In this unit you will consider what data analysis techniques are. You will also learn the various types of data analysis techniques like modeling, simulation, algorithm, conceptualization and abstraction.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what data analysis techniques are
- describe the various types of data analysis techniques like modeling, simulation, algorithm, conceptualization and abstraction.

3.0 MAIN CONTENT

3.1 What is Data Analysis?

Data analysis is the process of systematically applying statistical and/or logical techniques to describe, illustrate, condense, recap, and evaluate data. It's also a process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making. This form of analysis is just one of the many steps that must be completed when conducting a research. Data from various sources is gathered, reviewed, and then analyzed to form some sort of finding or conclusion.

Data analysis in qualitative research includes statistical procedures. And many times, analysis becomes an ongoing iterative process where data is continuously collected and analyzed almost

simultaneously. Indeed, researchers generally analyze for patterns in observations through the entire data collection phase. The form of data analysis is determined by the specific qualitative approach taken and the form of the data. Accurate and appropriate analysis of research findings ensures data integrity. On the other hand, improper statistical analyses distort scientific findings, mislead casual readers, and may negatively influence the public perception of research.

Data analysis itself is a phase in the data process cycle. The data process itself is composed of the following phases:
A. Data Collection Phase
- 1. Define the question
- 2. Determine the sampling method
B. Data Analysis Phase (Descriptive)
- 3. Explore the data
- 4. Summarize the data
C. Data Analysis Phase (Inferential)
- 5. Look for statistical significance

3.2 Steps to Data Analysis (or Data Analysis Model)
The goal of data analysis is to enable an organisation to make better decisions. This is in such a way as to build products that allow everyone in the organization to use data better, enabling data-driven decision making in every department and at every level.

Modern data analysis is meant to be captured in products that automatically collect, clean and analyze data, delivering information and predictions for executive reports. Thus data analysis runs automatically and continuously as new data arrives and the data scientists can work with the organisation on refining the models and improving prediction accuracy.

Although each organisation has its own data requirements and goals, there are seven steps that remain consistent across organizations and their data analysis processes:

3.2.1: Identify Organisation Need(or Data Requirement)
This is the first step of the data value chain and must happen before there is data: the organisation has to identify its problem, requirement or need. This will enable it to decide on the objectives for the data science teams. These objectives usually require significant data collection and analysis. The objective for data science teams is to develop a quantifiable way (called Problem Statement) to determine whether the organisation is progressing toward its goals; identify metrics or performance indicators early.

3.2.2: Data collection
As a second step, all the data sources related to the problem statement will be identified and pulled into a central repository. Gather as much data from diverse sources as possible in order to find better correlations, build better models and find more actionable insights. The data sources can vary from SQL databases to text files to csv files to online data. The data may be collected from sensors in the environment, such as traffic cameras, satellites, recording devices, etc. It may also be obtained through interviews, downloads from online sources, or reading documentation.

20

3.2.3: Data Cleaning

The first critical step in data analysis is to improve data quality by data cleaning. Here, data scientists correct spelling mistakes, handle missing data and weed out junk information. This is important because even with the best data analysis, junk data will generate wrong results and mislead the organisation. So it is especially important that this step will scale, since having continuous data value chain requires that incoming data will get cleaned immediately and at very high rates. This usually means automating the process so as to improve data quality, generate the right results and avoid making incorrect conclusions.

3.2.4: Exploratory Data Analysis

Once the data is cleaned, it can be analyzed by exploration so as to begin understanding the messages contained in the data. The process of exploration may result in additional data cleaning or additional data collection, so these activities may be iterative in nature. Descriptive statistics, such as the average or median, may be generated to help understand the data. Data visualization may also be used to examine the data in graphical format, to obtain additional insight regarding the messages within the data.

3.2.5: Data Modeling and Algorithms

Mathematical formulas or models called algorithms may be applied to the data to identify relationships among the variables, such as correlation or causation. In data modeling, models are built that correlate the data with the organisation outcomes and make recommendations regarding changes to be made. This is where the unique expertise of data scientists and analysts becomes critical to organisation success—correlating the data and building models that predict organisation outcomes. They may attempt to build models that are descriptive of the data to simplify analysis and communicate results.

3.2.6: Data product(ion)

A data product is a computer application that takes data inputs and generates outputs, feeding them back into the environment. It may be based on a model or algorithm. An example is an application that analyzes data about customer purchasing history and recommends other purchases the customer might enjoy.

3.2.7: Data Optimization and Communication

Once the data is analyzed, it may be reported in many formats to the users of the analysis to support their requirements. Since the data value chain is a repeatable process, the users may have feedback, which results in additional analysis. This leads to continuous improvements of both the data and the organisation as a whole. As such, much of the data analytical cycle is iterative.

When determining how to communicate the results, the analyst may consider data visualization techniques to help clearly and efficiently communicate the message to the audience. Data visualization uses information displays (such as tables and charts) to help communicate key messages contained in the data. Tables are helpful to a user who might lookup specific numbers,

while charts (e.g., bar charts or line charts) may help explain the quantitative messages contained in the data.

3.3 Introduction to Data Analysis Techniques

It's known today, that data is no longer scarce – it's overpowering. The key is to sift through the overwhelming volume of data available to organizations and correctly interpret its implications. But to sort through all this information, you need the right statistical data analysis tools.

With the current obsession over "big data," analysts have produced a lot of fancy tools and techniques available to large organizations. However, there are a handful of basic data analysis tools that most organizations aren't using…to their detriment. We shall discuss the five fundamental data analysis techniques.

3.3.1: *Mean*

The arithmetic mean, more commonly known as "the average," is the sum of a list of numbers divided by the number of items on the list. The mean is useful in determining the overall trend of a data set or providing a rapid snapshot of your data. Another advantage of the mean is that it's very easy and quick to calculate. However, taken alone, the mean is a dangerous tool. In some data sets, the mean is also closely related to the mode and the median (two other measurements near the average).

3.3.2: *Standard Deviation*

The standard deviation, often represented with the Greek letter σ (sigma), is the measure of a spread of data around the mean. A high standard deviation signifies that data is spread more widely from the mean, while a low standard deviation signifies that more data align with the mean. The standard deviation is useful as a data analysis technique in that it quickly determines dispersion of data points. However, just like the mean, the standard deviation is deceptive if taken alone.

3.3.3: *Regression*

Regression models the relationships between dependent and explanatory variables, which are usually charted on a scatterplot. The regression line also designates whether those relationships are strong or weak. Its major pitfall is that it is not very nuanced. Sometimes, the outliers on a scatterplot (and the reasons for them) matter significantly.

3.3.4: *Sample Size Determination*

When measuring a large data set or population – example, a workforce – you don't always need to collect information from every member of that population; a sample does the job just as well. The important thing is to determine the right size for a sample to be accurate. Using proportion and standard deviation methods, you are able to accurately determine the right sample size you need to make your data collection statistically significant. The main disadvantage of sample size determination is that when studying a new, untested variable in a population, your proportion equations might need to rely on certain assumptions.

3.3.5: *Hypothesis Testing*

This is commonly called t testing, hypothesis testing assesses if a certain premise is actually true for your data set or population. In data analysis and statistics, you consider the result of a hypothesis test statistically significant if the results couldn't have happened by random chance. It's pitfalls are the common errors. For example, the placebo effect occurs when participants falsely expect a certain result and then perceive (or actually attain) that result.

22 **odeling and Simulation**

In modeling and simulation (M&S), computers are used to compute the results of some physical phenomenon. Here, the computer is first used to build a mathematical model which contains all the parameters of physical model and represent physical model in virtual form then conditions are applied which we want to experiment on physical model. Next, simulation starts i.e, the computer is left to compute/calculate the results of those conditions on mathematical model.

3.4.1: Data Modeling

Data modeling is a process used to define and analyze data requirements needed to support the organisation processes within the scope of corresponding information systems in organizations. It is a step in the data analysis process and starts after the critical step of data cleaning with uncovering patterns of exploratory analysis in existing data, which are then used to predict/forecast future variations in the parameters of interest. It involves extracting features from the data and feeding them into the machine learning algorithms to build a model.

Data modeling is the solution proposed for the problem statement and involves three steps: model selection, model training and model evaluation.

Model selection: A model is built based on the type of organisation problem or need. For example, if the objective of the analysis is to predict a future event, we need to build a Regression model for prediction.

Model Training: After selecting the Model for the analysis, the entire dataset is divided into 2 parts – Training data & Test Data. Seventy-five percentage of the entire data will be fed as input to the Model Algorithms.

Model Evaluation: Once the model is built. The next step is to test the model & validate it. The data used for testing the model is the remaining twenty-five percent of the dataset in the previous step.

There are three different types of data models produced in the course of data analysis, while progressing from requirements to the actual database to be used for the information system. These are:

- conceptual data model
- logical data model
- physical data model

The data requirements are initially recorded as a *conceptual data model.* Conceptual data model is essentially a set of technology independent specifications about the data, used to discuss initial requirements with the organisation's stakeholders. The conceptual model is then translated into a *logical data model.* The logical model documents structures of the data that can be implemented in databases. Implementation of one conceptual data model may require multiple

logical data models. The last step in data modeling is transforming the logical data model to a *physical data model.* The physical model then organizes the data into tables, and accounts for access, performance and storage details.

Data modeling defines not just data elements, but also their structures and the relationships between them. Data modeling techniques and methodologies are used to model data in a standard, consistent, predictable manner in order to manage it as a resource. The use of data modeling standards is strongly recommended for projects requiring a standard means of defining and analyzing data within an organization.

Examples of projects that will benefit from data modeling include the following:

- Project to assist business analysts, programmers, testers, manual writers, IT package selectors, engineers, managers, related organizations and clients to understand and use an agreed semi-formal model the concepts of the organization and how they relate to one another
- Project to manage data as a resource
- Project for the integration of information systems
- Project for designing databases/data warehouses (also called data repositories)

According to Whitten et al. (2004), data modeling can be divided into two types: strategic data modeling and data modeling during systems analysis. Strategic data modeling is part of the creation of an information systems strategy, which defines an overall vision and architecture for information systems. This approach is embraced by the methodology of information engineering. Then data modeling during systems analysis is logical data model created as part of the development of new databases in systems analysis.

3.4.2: Simulation in Data Analysis

There are several ways to use simulations: physical simulations of a process, simulating a game or situation to estimate the chances of certain outcomes, using probability models to simulate data to estimate the chance of a particular outcome, or simulating data while varying parameters to illustrate a concept or deepen students' understanding of a process. Another use of simulation is to generate data under a certain theory to test whether a particular outcome is surprising (e.g., if a student correctly identifies 8 out of 10 samples of cola correctly in a blind taste test, determining if this is just due to chance/guessing by simulating data based on what could be expected if the person is guessing and comparing their result to a simulated sampling distribution).

In research methodology, the term simulation analysis is used to mean a method, wherein the infinite calculations are made to obtain the possible outcomes and probabilities for any choice of action. It is the estimation of the probabilities of different possible outcomes, e.g., from an investment project. The concept of simulation analysis can be appreciated by considering the following steps involved in it:

i. Model the Project: A model shows how the net present value (NPV) is related to the parameters and the exogenous variables. The parameters are the variables specified by the

decision maker and are held constant throughout the simulation, whereas the exogenous variables are randomly determined and are beyond the control of the decision maker.
ii. The next step is to specify the values of the parameters and assign probabilities to the random variables that arise from the external factors.
iii. Randomly, select any value from the probability distribution of each of the exogenous variables.

ompute the NPV for both the randomly generated values of exogenous variables and the parameter values, as specified by the decision maker.
v. Repeat the step iii and iv again and again, to get a large number of simulated values of NPV.

This whole process of simulation analysis compels the decision maker to consider all the interdependencies and uncertainties characterizing the project. Thus, the viability of the project is determined on the basis of number of outcomes and the probabilities realized through a series of actions performed during the simulation analysis.

3.5 Algorithm, Conceptualization and Abstraction

Algorithm is a process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer. *Conceptualization* is the ability to formulate an idea or concept. The conceptualization phase of a research project occurs in the initial design activity when the scope of the research is drafted and a list of the desired design features and requirements is created. Then, *abstraction* is a conceptual process where general rules and concepts are derived from the usage and classification of specific examples, literal (real or concrete) signifiers, first principles, or other methods. In software engineering and computer science, abstraction is the process of removing physical, spatial, or temporal details or attributes in the study of objects or systems in order to more closely attend to other details of interest.

3.5.1 Algorithm

An algorithm can be described as a procedure, formula or step-by-step demonstration of data processing or problem solving operation. Algorithm can also be defined as "A sequence of steps to be carried out for a required output from a certain given input". There are 3 main features of algorithm from this later definition:
1) The essential aim of an algorithm is to get a specific output,
2) An algorithm involves with several continuous steps,
3) The output comes after the algorithm finished the whole process.

Algorithms are also mathematical models that may be applied to the data to identify relationships among the variables, such as correlation or causation. In general terms, models may be developed to evaluate a particular variable in the data based on other variable(s) in the data, with some residual error depending on model accuracy (i.e., Data = Model + Error). Basically, all algorithms perform logically while following the steps to get an output for a given input. It can be widely used in various areas: computer programming, mathematics and even in daily lives.

Types of Algorithm

Algorithms can be classified into 3 types based on their structures:

1) Sequence: this type of algorithm is characterized with a series of steps, and each step will be executed one after another.
2) Branching: this type of algorithm is represented by the "if-then" problems. As an example, if a condition is true, the output will be A; if the condition is false, the output will be B. This algorithm type is also known as a "selection type".
3) Loop: for this type, the process might be repeatedly executed under a certain condition. represented by "while" and "for" problems. But make sure the process will end after a number of loops under the condition. This algorithm type is also known as "repetition type".

Applications of Algorithm
Algorithms are often represented in flowchart form for visual understanding as they are used in many areas. So, a flowchart is a diagram that represents an algorithm, showing the steps in various boxes and displays the process by connecting the boxes together. As an example, the Algorithm Application for Computer Programming in Figure 2.1 below:

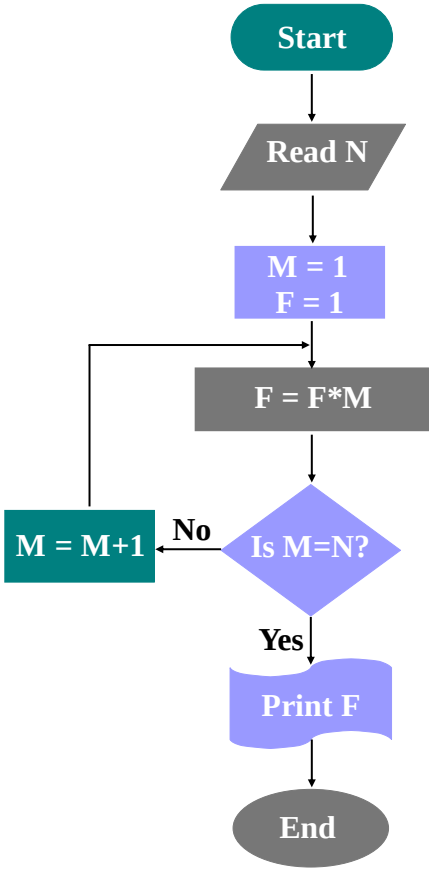


Figure 1: Application for Computer Programming
(A flowchart for computing factorial N (N!))

3.5.2 Conceptualization
Conceptualization is the process of specifying exactly what we mean and don't mean by the terms we use in our research. It is a mental process of organizing one's observations and

experiences into meaningful and coherent wholes. Conceptualization is derived from the word concept, which could be a word or complex set of events or ideas referred by the word.

Data-gathering process is a complex interplay between the conceptual process and the actual observation or measurement process. Conceptualization is in fact one of the first steps in the
 urement process. This has to do with defining our terms as clearly as possible and also not taking ourselves too seriously in the process. Our definitions mean only what we say they mean—nothing more and nothing less.

Research is always based on reliable data and the methods used to capture this data. Scientific methods facilitate this process to obtain quality output in research. Formulation of research problem is the first step to begin with research. It is at this stage, the researcher should have a clear understanding of the words and terms used in the research such that there are no conflicts arising later regarding their interpretation and measurements. This necessitates the understanding of the conceptualization process.

Concept and Conceptuality
Concept is part of the process of measurement, and this portion of the process is called conceptualization. On the other hand, conceptualization refers to the careful analysis of general ideas known as concepts. It's an intellectual process and takes us from the realm of vague, ambiguous 'concepts' to clearer, more distinct 'constructs'. Constructs are sufficiently concrete that researchers can develop measures of them. Conceptualization involves writing out clear, concise definitions for our key concepts.

As an example, the term *Socialization:* what comes to mind when you read that term? How do you know socialization when you see it? Does it have something to do with public perception? If so, perhaps we could define socialization as the public perceives a person. At this early stage of socialization, brainstorming about the images conjured up by concepts and playing around with possible definitions is appropriate. But this is just the first step.

It would make sense as well to consult other previous research and theory to understand if other scholars have already defined the concepts we're interested in. This doesn't necessarily mean we must use their definitions, but understanding how concepts have been defined in the past will give us an idea about how our conceptualizations compare with the predominant ones out there. Understanding prior definitions of our key concepts will also help us decide whether we plan to challenge those conceptualizations or rely on them for our own work.

So, conceptualization isn't quite as simple as merely applying any random definition that we come up with to a term. Sure, it may involve some initial brainstorming, but conceptualization goes beyond that. Once we've brainstormed a bit about the images a particular word conjures up for us, we should also consult prior work to understand how others define the term in question. And after we've identified a clear definition that we're happy with, we should make sure that every term used in our definition will make sense to others. Are there terms used within our definition that also need to be defined? If so, our conceptualization is not yet complete.

3.5.3 Abstraction

Abstraction is the act of representing essential features without including the background details or explanations. In the computer science and software engineering domain, the abstraction principle is used to reduce complexity and allow efficient design and implementation of complex software systems. Some areas of software design and implementation where the abstraction principle is applied include programming languages (mainly in object-oriented programm 27 languages), specification languages, control abstraction, data abstraction and the architecture of software systems.

In object-oriented programming, abstraction is one of three central principles (along with encapsulation and inheritance). Through the process of abstraction, a programmer hides all but the relevant data about an object in order to reduce complexity and increase efficiency. In the same way that abstraction sometimes works in art, the object that remains is a representation of the original, with unwanted detail omitted. The resulting object itself can be referred to as an abstraction, meaning a named entity made up of selected attributes and behavior specific to a particular usage of the originating entity. Abstraction is related to both encapsulation and data hiding.

In the process of abstraction, the programmer tries to ensure that the entity is named in a manner that will make sense and that it will have all the relevant aspects included and none of the extraneous ones. A real-world analogy of abstraction is this: You travelled by air to present a plenary paper in a conference overseas and are arranging to be picked by your host, and are deciding what to tell him so that he can recognize you in the airport. Your host decides to include the information about where he will be, his hair color, the color of his jacket and probably a placard containing your name.

This is all the data that will enable the procedure (your host finding you) work smoothly. He should include all that information. On the other hand, there are a lot of bits of information about him that aren't relevant to this situation: his social security number and his admiration for obscure films are all irrelevant to this particular situation because they won't help your date find you.

Abstraction is applied in the process of identifying software artifacts (objects) to model the problem domain. It is the process of reducing these objects to their essence such that only the necessary elements are represented. Abstraction defines an object in terms of its properties, functionality, and interface (means of communicating with other objects).These methods are used to reduce the complexity of the design and implementation process of software. In that process, the designers define abstract object actors that are able to perform work, change their state and communicate with other actors. The state of the object is encapsulated while the detailed data structures associated with the object are kept behind the scenes.

4.0 Conclusion

In this unit you have studied data analysis techniques. You also learnt the various types of data analysis and processing techniques like modeling, simulation, algorithm, conceptualization and abstraction.

5.0 Summary

In this unit, data analysis is the process of systematically applying statistical and/or logical techniques to describe, illustrate, condense, recap, and evaluate data. It involves data analysis techniques like modeling, simulation, algorithm, conceptualization and abstraction.

28 **utor-Marked Assignment**

1. What is Data Analysis?
2. List and briefly discuss Data Analysis Model
3. Enumerate briefly on the various data analysis techniques
4. Write short notes on the following:

modeling, simulation, algorithm, conceptualization and abstraction.

7.0 References/Further Readings

1. Wikipaedia (2018). Data analysis @ <https://en.wikipedia.org/wiki/Data_analysis>
2. Dillard J. (2018). 5 Most Important Methods For Statistical Data Analysis, Big Sky 25
<https://www.bigskyassociates.com/blog/bid/356764/5-Most-Important-Methods-For-Statistical-Data-Analysis>
3. Shapira G. (n.d.). The Seven Key Steps of Data Analysis, Oracle @ <http://www.oracle.com/us/corporate/profit/big-ideas/052313-gshapira-1951392.html>
4. Whitten, Jeffrey L.; Lonnie D. Bentley, Kevin C. Dittman. (2004). *Systems Analysis and Design Methods*. 6th edition. ISBN 0-256-19906-X.
5. Wikipaedia (2018). Data modeling @ <https://en.wikipedia.org/wiki/Data_modeling>
6. Edraw (2018). What is Algorithm - Definition, Types and Application @ https://www.edrawsoft.com/algorithm-definition.php

Module 3: ICT Research Methodology
Unit 1 ICT Research Life Cycle
Unit 2 Methods and Approaches Applicable to the Conduct of ICT Research.
Unit 3 Design and Communication of Research Proposals for ICT Projects

UNIT 1 ICT RESEARCH LIFE CYCLE

CONTENTS

1.0 INTRODUCTION
In this unit you will consider the process of ICT research and the ICT research life cycle.

2.0 OBJECTIVES
After going through this unit, you should be able to:
- discuss the process of ICT research
- describe the stages in the ICT research life cycle.

3.0 MAIN CONTENT
3.1 The Process of ICT Research
ICT Research is like any other scientific research. What makes ICT Research peculiar is the use of ICT in the conduct of the research. The process of ICT Research therefore consists of series of steps necessary to effectively carry out the research. Although the steps may overlap, the following order provides a useful procedural guideline regarding the research process:
- formulating the research problem;
- extensive literature survey;
- developing the hypothesis;
- preparing the research design;
- determining sample design;
- collecting the data;

- execution of the project;
- analysis of data;
- hypothesis testing;
- generalisations and interpretation, and
- preparation of the report or presentation of the results, i.e., formal write-up of conclusions reached.

It should be noted that the various steps involved in the research process are not mutually exclusive. So they are not quite separate and distinct. Again, they do not necessarily follow each other in any specific order.

3.1.1. Formulating the Research Problem

Research problems can be two types:
1) those which relate to states of nature and
2) those which relate to relationships between variables.

Essentially two steps are involved in formulating the research problem:
1) understanding the problem thoroughly, and
2) rephrasing the same into meaningful terms from an analytical point of view.

This task of formulating, or defining, a research problem is a step of greatest importance in the entire research process. Also the statement of the objective of the research problem is very important because it determines the data to be collected, the characteristics of the data which are relevant, relations which are to be explored, the choice of techniques to be used in these explorations and the form of the final report.

3.1.2. Extensive Literature Survey

Once the problem is formulated, a brief summary of it should be written down. At this juncture the researcher should undertake extensive literature survey connected with the problem. For this purpose, the abstracting and indexing journals and published or unpublished bibliographies are the first place to go to. Academic journals, conference proceedings, government reports, books etc., must be tapped depending on the nature of the problem. A good library and the internet will be of great help to the researcher at this stage.

3.1.3. Development of Working Hypotheses

After extensive literature survey, the next step is for the researcher to state in clear terms the working hypothesis or hypotheses. Working hypothesis is tentative assumption made in order to draw out and test its logical or empirical consequences. As such the manner in which research hypotheses are developed is particularly important since they provide the focal point for research. Hypothesis should be very specific and limited to the piece of research in hand because it has to be tested. The role of the hypothesis is to guide the researcher by delimiting the area of research and to keep him on the right track. It also indicates the type of data required and the type of methods of data analysis to be used.

3.1.4. Preparing the Research Design

With the research problem formulated in clear terms, the researcher will be required to prepare a research design, i.e., to state the conceptual structure within which the research would be conducted. The function of research design is to provide for the collection of relevant evidence with minimal expenditure of effort, time and money. But how all these can be achieved depe 31 mainly on the research purpose. A research purpose can be of any of these four categories:

1) Exploration,
2) Description,
3) Diagnosis, and
4) Experimentation.

The preparation of the research design, appropriate for a particular research problem, involves the following considerations:

- the means of obtaining the information;
- the availability and skills of the researcher and his staff (if any);
- explanation of the way in which selected means of obtaining information will be organized and the reasoning leading to the selection;
- the time available for research; and
- the cost factor relating to research, i.e., the finance available for the purpose.

3.1.5. Determining Sample Design

A sample design is a definite plan determined before any data are actually collected for obtaining a sample from a given population. For example, the plan to select 12 of acity's 200 drugstores in a certain way constitutes a sample design. Samples can be either probability samples or non-probability samples. With probability samples each element has a known probability of being included in the sample but the non-probability samples do not allow the researcher to determine this probability. Probability samples are those based on simple random sampling, systematic sampling, stratified sampling, cluster/area sampling whereas non-probability samples are those based on convenience sampling, judgment sampling and quota sampling techniques.

3.1.6. Collecting the Data

It is always necessary to collect data that are appropriate because it is often found that data at hand are inadequate in dealing with any real life problem. Several ways of collecting the appropriate data exist and differ considerably in context with respect to money costs, time and other resources. Primary data, for instance, can be collected either through experiment or through survey.

In collecting data by experiment, the researcher observes some quantitative measurements, or the data, with the help of which he examines the truth contained in his hypothesis. On the other hand, using survey, data can be collected by any one or more of the following ways: by observation, through personal interview, through telephone interviews, by mailing of questionnaires, through schedules.

3.1.7. Execution of the Project

This is a very important step in the research process. If the execution of the project proceeds on correct lines, the data to be collected would be adequate and dependable. The researcher should see that the project is executed in a systematic manner and on time. If the survey is to be conducted by means of structured questionnaires, data can be readily machine-processed. In such a situation, questions as well as the possible answers may be coded. If the data are to be collected
32 gh interviewers, arrangements should be made for proper selection and training of the ınterviewers. The training may be given with the help of instruction manuals which explain clearly the job of the interviewers at each step.

3.1.8. Analysis of Data

After data collection, comes data analysis. The analysis of data requires a number of closely related operations such as establishment of categories, the application of these categories to raw data through coding, tabulation and then drawing statistical inferences. The unwieldy data should necessarily be condensed into a few manageable groups and tables for further analysis. Thus, the researcher should classify the raw data into some purposeful and usable categories.

3.1.9. Hypothesis-testing

After analyzing the data, the researcher is in a position to test the hypotheses (if any) he had formulated earlier. Do the facts support the hypotheses or they happen to be contrary? This is the usual question which should be answered while testing hypotheses. Various tests, such as Chi square test, t-test, F-test, have been developed by statisticians for the purposes of testing hypotheses. The hypotheses may be tested through the use of one or more of such tests, depending upon the nature and object of research inquiry. Hypothesis-testing will result in either accepting the hypothesis or in rejecting it. If the researcher had no hypotheses to start with, generalisations established on the basis of data may be stated as hypotheses to be tested by subsequent researches in times to come.

3.1.10. Generalisations and Interpretation

If a hypothesis is tested and upheld several times, it maybe possible for the researcher to arrive at a generalisation, i.e. a theory. As a matter of fact, the real value of research lies in its ability to arrive at certain generalisations. If the researcher had no hypothesis to start with, he might seek to explain his findings on the basis of some theory. This is known as interpretation. The process of interpretation may quite often trigger off new questions which in turn may lead to further researches.

3.1.11. Preparation of the Report or the Thesis

Finally, the report of what has been done has to be prepared. The report must be written with great care keeping the following points in view:

1) The layout of the report should be as follows:

- the preliminary pages;
- the main text, and
- the end matter.

The preliminary pages of the report should have the following:

- title and date
- acknowledgements
- foreword
- table of contents
- list of tables
- list of graphs and charts (if any).
- The main text of the report should have the following parts:
- Introduction
- Summary of findings
- Main report
- Conclusion
- The end matter should contain the following:
- Appendices
- Bibliography
- Index

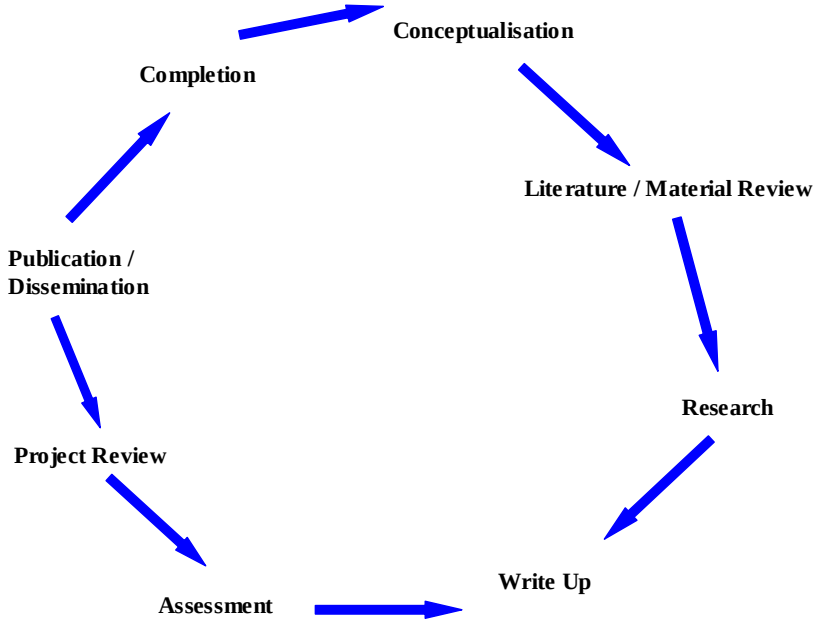
2). Report should be written in a concise and objective style in simple language avoiding vague expressions such as 'it seems,' 'there may be', and the like.

3). Charts and illustrations in the main report should be used only if they present the information more clearly and forcibly.

4). Calculated 'confidence limits' must be mentioned and the various constraints experienced in conducting research operations may as well be stated.

3.2 ICT Research Life Cycle

The ICT Research life cycle model provides a graphic perspective of how a typical ICT research project, research thesis, or any similar research process work may be visually conceived. The research life-cycle is composed of the following: conceptualisation, literature/material review, research, write up, assessment, project review, publication/dissemination and completion. A typical ICT research project (dissertation, thesis, funded project, etc.) will develop along a path from conceptualisation to completion. Figure 3.1 below demonstrates a typical ICT Research Life-cycle (IRL).



It must be noted that the phases in the life-cycle (examples, Conceptualisation, Literature / 34 al Review, Research etc.) are not necessarily constant for every (project) research. Each research varies in content, context and perspective which affect these phases in terms of relevance / applicability and/or placement. The successful completion of any project (research), especially in this digital age, relies on a clear and concise research life-cycle strategy.

The life-cycle is a continuous, cycling loop that may flow from one piece of research into another. The elements of different research may overlap with the current research, and phases may be developed in partnership (as in a multi-disciplinary and/or multi-institutional project). Each piece of research will have its own lifecycle that applies, but is not necessarily independent of other project lifecycles. Nevertheless, if any of the phases is missed or skipped, without any consideration to the research's peculiarity, there will be an impact on the entire research. This may lead to serious delays, poor quality outcomes, or even complete failure.

3.2.1 Conceptualistion

Conceptualisation identifies what is being researched, such as:

- Recognise what "data" are being researched and what the intention is for these data.
- Where is the data coming from?
- Why is the data being targeted?
- How accessible is the data?
- Is the data relevant to the research remit?

3.2.2 Literature/Material review

This describes the data by providing a full description of the data is essential in order to properly understand its relevance and validity. At this point, irrelevant, inaccurate and spurious data can be identified. Data that clearly assists in the research process can be effectively "tagged". This process is essentially the same as the Literature Review. Here, the following happens:

- Each data source must be referenced accurately
- Each data element, or group of elements should be verified
- The formats of each element must be clearly identified
- The physical dimensions, resolution, and/or storage capacity must be identified
- Copyright and ethical considerations need to be fully accounted for
- Any licensing restrictions that apply should be identified
- Protocols for holding the data need to be checked
- Accurate naming and referencing conventions must be applied to ensure accessibility

3.2.3 Research

In research the following activities are performed:

- Preserve
- Conceptualize
- Create or Receive
- Appraise and Select
- Ingest
- Preservation action
- Storage

Preserve: The research phase incorporates several aspects of the data management pr . Preservation of the data is crucial to the availability and accessibility during the project, and possibly beyond.

Conceptualize: Here, you plan how the data will be generated, created or incorporated into the research. Consider how the data will be captured, and how/where it will be stored.

Create or Receive: As part of the research process, new and innovative data may be created. Similarly, data new to the project may come to light and be received for incorporation into the project. These forms of data will need to be processed in much the same way as other data.

Appraise and Select: Data must be evaluated to determine its validity for the research process. It is vital that documented guidance, policies and legal requirements are adhered to.

Ingest: Data gathered or created will need to be placed into an archive, repository or data centre. This goes beyond simply holding data on a local computer or a data stick. Transfer to a robust repository is strongly recommended. Again, local institution policies must be adhered to when data is transferred.

Preservation Action: Based on the planning carried out in the previous review phase, the long-term preservation of the data must be enacted. This may require the researcher to comply with a strict file naming process, removing inappropriate, irrelevant and/or repeated information. The file structures and integrity of the data must be checked and verified.

Storage: Once the relevant checks have been carried out, the data should be stored in the appropriate location.

3.2.4 Write Up

Having carried out the relevant research, including the various data management aspects detailed before, the data will now be readily accessible for use and reuse in the writing up of the work. The actual writing up is the remit of the researcher – a basic function of "doing history" and will not be explored here. During this phase, attention should still be focused on the elements identified during the research phase.

3.2.5 Assessment

The project assessment phase relates to checks carried out by project mentors, tutors, supervisors, team leaders, colleagues, etc. At this point, the researcher is afforded the opportunity to receive constructive criticism and identify areas of required development. Shortfalls in terms of data security or integrity could be examples of identified areas for further work.

3.2.6 Project Review

Based on the Assessment phase, identified areas of further development may be addressed. This requires the researcher to repeat all previous phases and implement the identified elements from the assessment. This is also the opportunity for a full review of the processes at each point of the cycle. Corrections and amendments can be safely applied.

3.2.7 Publication/Dissemination

Following the review, with corrections applied and all reasonable steps taken to maximise the integrity of the overall project, the result of the research be published or disseminated. Published data may take the form of, for example, a database or datasets provided online.

 phase may be the prompt for the researcher to formulate different formats of availability. For example, a database may be provided online via a website, as well as held locally on an institutional repository for local use.

Vitally, the extent of the data to be published is affected at this juncture. The researcher will identify which specific elements of the researched data are to be published, and which elements do not need to be made available.

3.2.8 Completion

Completion of a (project) research invariably leaves the researcher with the insight that if more time and resource were available, even more could have been achieved. In terms of data management, this aspect is vital to the overall process.

Any data collected and collated during the project remains valid and important after the specific research has been carried out and the project is complete. Access to the data remains a legacy of the completed project, and often spawns new or continuing projects that build on the existing research.

Disposal and Migration: At some point the data will eventually be disposed of, or it may need to be moved from one location to another. With awareness of these issues, disposal of useable, valuable data may be avoided. Continuing monitoring of the availability and location of data will ensure its continued viability for future use. Similarly, data are often altered in format to overcome issues of obsolescence in terms of hardware or software.

4.0 Conclusion

In this unit you have studied the process of ICT research and described the stages in the ICT research life cycle.

5.0 Summary

In this unit, ICT Research is like any other scientific research. What makes it peculiar is the use of ICT in the conduct of the research. The process of ICT Research consists of series of steps necessary to effectively carry out the research.

6.0 Tutor-Marked Assignment

1. Itemize the processes of ICT research
2. Enumerate the stages of ICT Research life-cycle

7.0 References/Further Readings

1. The History Data Management Lifecycle (HDML) model (2018). Postgraduate online research training @ <https://port.sas.ac.uk/mod/book/tool/print/index.php?id=1220>
2. Human Kinetics (2018). Steps of the Research Process @ <https://uk.humankinetics.com/blogs/excerpts/steps-of-the-research-process>

UNIT 2 METHODS AND APPROACHES APPLICABLE TO THE CONDUCT OF IC RESEARCH.

CONTENTS

1.0 INTRODUCTION

In this unit you will learn the methods and approaches applicable to Quantitative Research. You will also learn the methods and approaches applicable to Qualitative Research.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what methods and approaches are applicable to Quantitative Research
- enumerate the methods and approaches that are applicable to Qualitative Research

3.0 MAIN CONTENT

There are many dimensions in research methods for the field of ICT. The methodology varies in terms of topic of interest, scope, validity of instruments and knowledge body. It is recommended that information and communication technology researchers should not blindly adopt a research method. The choice of research method should be made in relation to the research objectives. It is important to note that information and communication technology research is more than the study of *technology* or *behaviour*. It is suggested that ICT researchers should deal with the phenomena that emerge when the *technology* and the *behaviour* interact, much like different chemical elements reacting to one another when they form a compound.

3.1 Methods and Approaches Applicable to Quantitative Research

The methods and approaches applicable to or used in quantitative research are classified on the basis of data collection sources. Because quantitative research methods are highly numerical and the results in form of data, the analysis of the data is numerical and so the data collection is also done in form of numbers. There are four common types of quantitative research methods:

- Survey Research
- Correlational Research
- Causal-Comparative Research
- Experimental Research

Survey Research

Survey Research is a quantitative research method used to ask questions to a sample of respondents using sources such as online polls, surveys, questionnaires via Email, Social Media or embedding on a website. Every small and big organization intends to understand what their customers think about their products and services, how well are new features faring in the market and other such details.

This type of research can be conducted with a specific target audience group or across multiple groups along with comparative analysis. A prerequisite for this type of research is that the sample of respondents must have randomly selected members. This way, a researcher can easily maintain the accuracy of the obtained results as a huge variety of respondents will be addressed using random selection.

Traditionally, survey research was conducted face-to-face or via phone calls but with the progress made by online mediums such as email or social media, survey research has spread to online mediums as well. An example of a survey research question is: What are your thoughts on our current website?

3.1.2. Correlational Research

Correlation research is conducted to establish a relationship between two closely knit entities; how one impacts the other; and what changes are eventually observed. This research method is carried out to give value to naturally occurring relationships and a minimum of two different groups are required to successfully conduct this quantitative research method. Without assuming different aspects, a relationship between two groups or entities must be established.

Researchers use this quantitative research method to correlate two or more variables using mathematical analysis methods. Patterns, relationships, and trends between variables are concluded as they exist in their natural set up. The impact of one of these variables on the other is observed along with how it changes the relationship between the two variables. Researchers tend to manipulate one of the variables to attain the desired results. A classical example of Correlational Research Question is: the equation between fame and money.

3.1.3. Causal-Comparative Research

This research method mainly depends on the factor of comparison. Another name for Causal-Comparative Research is *Quasi-Experimental Research.* This quantitative research method is

used by researchers to draw conclusions about cause-effect equation between two or more variables, where one variable is dependent on the other independent variable. The independent variable is established but not manipulated and its impact on the dependent variable is observed. These variables or groups must be formed as they exist in the natural set up.

Causal-comparative research is not restricted to the statistical analysis of two variables but extends to analyzing how various variables or groups change under the influence of the same changes. This research is conducted irrespective of the type of relation that exists between two or more variables. Statistical analysis is used to distinctly present the outcome of obtained using this quantitative research method. Example of Causal-Comparative Research Questions is: impact of drugs on a teenager.

3.1.4. Experimental Research

As the name suggests, Experimental Research is usually based on one or more theories. The theories have not been proved in the past and are merely a supposition. In an experimental research, an analysis is done around proving or disproving the statement. There can be multiple theories in experimental research. A theory is a statement which can be verified or refuted. After establishing the statement, efforts are made to understand whether it is valid or invalid.

3.2 Methods and Approaches Applicable to Qualitative Research

There are many methods in conducting qualitative research in ICT. Types of qualitative research methods include:

- Case Study
- Action Research
- Grounded Theory
- Content Analysis
- Ethnography

3.2.1 Case Study

A case study is an empirical investigation of phenomena within their environmental context, where the relationship between the phenomena and the environment is not clear. Thus, a case is examined to understand an issue or provide input to an existing theory or a new theoretical concept.

A research work deploying the case study method may have single or multiple cases. Conclusion could be drawn up from similarities or differences among the cases involved in a research work. For example, a researcher may use single case design to find the relationship that exists between user participation in systems development and the issue of organisational change surrounding the development and implementation of ICT systems.

Case studies can be in single or multiple design. Single case design is ideal for studying extreme cases, to confirm or challenge a theory or for cases where a researcher does not have access previously. However, it is important for a researcher to be careful during the interpretation of what is being observed. On the hand, multiple case design is appropriate when a researcher is

keen to use more than one case to gather data and draw up conclusion based on the facts retrieved. Multiple case design serves to confirm evidence which enhance the reliability and validity of a research work. An example of a multiple design case study is using multiple case design to investigate how an organisation may employ data to achieve its objectives through the development of multidimensional databases.

3.2.2 Action Research

Action research is associated with investigation on changes. It comprises a continuous process of research and learning in the researcher's long-term relationship with a problem. The intention of action research is to institute a process of change and then draw a conclusion based on this ess. Generally, in the field of Information and Communication Technology, technologies associated with ICT facilitate changes. Therefore, action research is an appropriate methodology to conduct investigation in ICT.

There are four stages in the action research cycle. They are as follows:

- Diagnosing: Identifies the research question
- Action Planning: Determines the actions to be undertaken to address the research
- Action Taking: Conducts and monitors the planned actions
- Evaluation: Determines if the actions have addressed the research question

Action research in ICT refers to both ICT system and people involved in that system. For example, a system administrator employed action research in his organisation to investigate the relationship between the introduction of groupware into an organisation and its implications towards individual work habits and the structure of enterprise architecture. Therefore, there are two reasons for action research in ICT:

1. To involve ICT practitioners in their work.; and
2. To encourage research with the purpose of bringing improvement in ICT systems, applications and infrastructure.

3.2.3 Grounded Theory

Grounded theory uses a prescribed set of procedures for analysing data and constructing theoretical model from them. It is discovery of theory from data systematically obtained social research. Although it originated from social research, the method now is widely used in ICT and other fields as well.

Grounded theory is very useful when current theories about a phenomenon are neither inadequate nor non-existent. Data collection for this method is field-based and likely to change over the course of the study. Interviews play a major role in this method but some other techniques like observation, multimedia resources and documents may also be used. A typical research example using this method is a qualitative view of analyst-client dialogue designed to explore analyst-client interaction from a processual perspective.

3.2.4 Content Analysis

A content analysis is a detailed and systematic examination of the contents of a particular material for identifying patterns or themes. It is typically performed on forms of human communication including journals, books, printed media and recorded human interactions. Out of the 5 research design methods listed above, content analysis involves thorough planning from the beginning itself. And research problem or research questions need to be specified from the beginning.

In ICT research, content analysis seems crucial especially when dealing with emails, online discussions and forums. Most content analyses aimed to answer questions directly to the research problem stated in a study. Steps involved in content analysis are the following:

- Identify the specific body of material needed to be explored
- Define the characteristics or qualities to be examined in precise terms
- Break into small and manageable segments of materials if it is too complex or lengthy.
- A researcher should scrutinise and sort the materials based on the defined characteristics.

3.2.5 Ethnography

Ethnography is a qualitative research method which involves a description of people and nature of phenomena. In ICT, ethnographic research method is increasingly employed to investigate information systems generally. Ethnography involves exploring the nature of phenomena and working with unstructured data, analysing data through interpretation of the meanings attributed by research respondents. This method involves primary observations conducted by a researcher during a stipulated period.

Normally, ethnographic method for ICT based research is deployed in a large organisation and involves detailed investigation of an entity within its specific context. Therefore, in such a context, detailed qualitative data need to be gathered regarding the body of knowledge. Data that are usually gathered using participant observation include field notes and unstructured interview. An example of ICT research conducted by ethnography will be a work employing an ethnographic investigation of information system technology development in an organisation.

The ethnographic method needs considerable time and fieldwork commitment by the researcher. It can be extremely time consuming as it involves the researcher spending a long time in the observation period and jotting down field notes. Common standard rules applied in taking field notes are the following:

- Jot down notes immediately and as soon as possible during observation
- Keep count of the number of phrases used by subjects
- Never neglect anything as insignificant
- Record sequence of events chronologically and period of events
- Avoid evaluative judgments or summarizing of retrieved facts and respondents.

4.0 Conclusion

In this unit you have learnt the methods and approaches applicable to Quantitative Research as well as the methods and approaches applicable to Qualitative Research.

5.0 Summary

In this unit, many dimensions exist in research methods for the field of ICT. It is recommended that information and communication technology researchers should not blindly adopt a research method because the choice of research method is made in relation to the research objectives.

6.0 Tutor-Marked Assignment

1. Explain briefly all the methods and approaches applicable to Quantitative Research
2. Discuss the methods and approaches applicable to Qualitative Research.

7.0 References/Further Readings

1. Bhat A. (2018). Quantitative Research: Definition, Methods, Types and Examples. QuestionPro @ <https://www.questionpro.com/blog/quantitative-research/>
2. Course Hero (2011). Topic 9: Qualitative Research Methods @ <https://www.coursehero.com/file/32204465/2011-0021-22-research-methodologypdf/>

UNIT 3 DESIGN AND COMMUNICATION OF RESEARCH PROPOSALS FOR ICT PROJECTS

CONTENTS

1.0 INTRODUCTION

In this unit you will learn about research proposals in ICT Projects. You will also learn how to design and communicate these proposals to an organisation.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what a research proposal is.
- design research proposals for ICT Projects
- communicate research proposals for ICT Projects

3.0 MAIN CONTENT

3.1 Research Proposals

A Research proposal is a document that is typically written by a scientist or academic which describes the ideas for an investigation on a certain topic. The research proposal outlines the process from beginning to end and may be used to request financing for the project, certification

for performing certain parts of research of the experiment, or as a required task before beginning a college dissertation.

Good research proposals quickly and easily answer the following questions:

- What do you want to do, and how do you plan to do it?
- How much will it cost, and how much time will it take?
- How does the proposed project relate to the proposer's or sponsor's interests (if sponsored) ?
- What difference will the project make to: your institution/organisation, your students, your discipline, the community, or any other concerned parties?
- What has already been done in the area of your project? Why should you, rather than someone else, do this project?
- How will the results be evaluated?

3.1.1 Types of Research Proposals

There are five common types of research proposal:

1. Solicited proposals
2. Unsolicited proposals
3. Preproposals
4. Continuation or non-competing proposals
5. Renewal or competing proposals

Solicited proposals

These are proposals submitted in response to a specific call issued by a sponsor. Such solicitations, typically called Request for Proposals (RFP), or Request for Quotations (RFQ), are usually have specific requirements for format and technical content, and may specify certain award terms and conditions.

Unsolicited proposals

Proposals submitted to a sponsor that has not issued a specific solicitation but is believed by the investigator to have an interest in the subject.

Preproposals

These are proposals requested by a sponsor who wants to minimize an applicant's effort in preparing a full proposal. Preproposals are usually in the form of a letter of intent or brief abstract. After the preproposal is reviewed, the sponsor notifies the investigator if a full proposal is warranted.

Continuation or non-competing proposals

This type of proposals confirms the original proposal and funding requirements of a multi-year project which the sponsor has already provided funding for an initial period (normally one year). Continued support is usually dependent on satisfactory work progress and the availability of funds.

Renewal or competing proposals
These are proposals which request continued support for an existing project that is about to end. These requests--from the sponsor's viewpoint--generally have the same status as an unsolicited proposal.

3.1.2 Components of a Research Proposal
Research proposals whether for sponsored or unsponsored activities generally follow a similar format. Their variations may depend on whether the proposer is seeking support for a research grant, a training grant, an academic pursuit or a conference / curriculum development project. Generally, the outline of a research proposal will covers the primary components of a research proposal.

Title Page: Titles are usually brief but comprehensive enough to indicate the nature of the proposed work.
Abstract: This is a brief summary of the proposed research. An effective summary states the problem addressed by the applicant, identifies the solution, and specifies the objectives and methods of the project. This summary should also outline funding requirements and the applicant's ability to source for funding.
Table of Contents: If the proposal is brief with few sections, it usually does not need a table of contents. However, long and detailed proposals may require a table of contents; in addition, a list of illustrations (or figures) and a list of tables may be included. The table of contents lists all major parts and divisions, including the abstract.
Introduction (including Statement of Problem, Purpose of Research, and Significance of Research): Normally, the introduction of a research proposal begins with a captivating statement and then proceeds to introduce the subject to the audience. The introduction should give enough insight into the problem or need warranting the research to enable an informed lay person to place the research problem in a context of common knowledge. It should also indicate the purpose of the research and show how its solution will advance the field or be important for some other work. The statement describes the significance of the problem(s), referring to appropriate studies or statistics.
*Background (including Literature Survey):*The background makes it clear what the research problem is and exactly what is to be or has been accomplished (if any).It also contains a literature review, which should be selective and critical. In the literature review, discussions of work done by others should lead the reader to a clear idea of how you will build upon past research and also how your work differs from theirs.
Description of Proposed Research (including Methods and Materials): This section is the heart of the proposal because it shows what you are going to do and how you intend to do it. It is actually the primary concern of the technical reviewers.

Spell out any preliminary work you have done in developing this method or in laying the groundwork; this is Phase 1.At the end of this phase you will be able to report that you have accomplished something and are ready to undertake Phase 2. The following section constitutes Phase 2 of the proposal.

Description of Relevant Institutional Resources: Generally this section details the resources available to the proposed project. In case of a sponsored research, it should show why the sponsor should select you and your institution/organisation for this particular research.
List of References: The style of the bibliographical item itself depends on the disciplinary field. The main consideration is consistency; whatever style is chosen should be followed carefully throughout the proposal.
Personnel: This should specify how many persons will be participating in the project. Any student participation, paid or unpaid, should be mentioned, and the nature of the proposed contribution detailed. This personnel section usually consists of two parts:

1. An explanation of the proposed personnel arrangements and
2. The biographical data sheets for each of the main contributors to the project.

Budget: Sponsors customarily specify how budgets should be presented and what costs are

able. The budget lays out the costs to be met by the funding source, including personnel, non-personnel, administrative, and overhead expenses.

3.2 ICT Projects

An ICT project can be described as a temporary endeavor in the field of ICT undertaken to create a unique product, service, or result. Every ICT project has five key attributes that play particular roles in the project development and completion. Key attributes are an important aspect of every project. Keeping these attributes in mind throughout the project can help you and your team meet established goals.

3.2.1 Attributes of ICT Projects

The five key attributes of ICT projects are the following:
1. *Purpose* - There must be a purpose to justify the need for a project. Many ideas for ICT projects can be discovered through company surveys or questionnaires aimed at determining needs. For example, in an e-learning corporation, a survey identified a need in the course development department for a program to log and maintain course status records. This becomes the purpose of the corporation's next ICT project.
2. *Length* – From the definition above, a project is "a temporary endeavor." This means that an ICT project has set beginning and end dates. The length of the project will depend on its complexity. For example, a short-term project might be developing a report on a company's needs. A long-term project might be the creation of a database for collecting and generating statistics.
3. *Resources*- Resources for an ICT project can include skilled employees from inside or outside of the company, hardware, software, and other assets as deemed necessary.
4. *Sponsors* - There may be many interested parties who have a stake in a project, but there is usually only one main sponsor. This main sponsor provides the needed direction and financing for the project. Non-financial sponsors may be acquired if the project incorporates many departments within an organisation.
5. *Uncertainty*- Every ICT project will usually face uncertainty. Anything can go wrong. Although efforts should be made to ensure that the ICT project plan is concise, factors such as time and cost can change due to unforeseen circumstances.

3.2.2 Phases of ICT Projects

Performing tasks in sequence is an important aspect of ICT projects. The phases of an ICT project, also known as a software development lifecycle, make up the framework of the project. The six phases of an ICT Project are listed below in sequence. This will help you to address the business needs of your project, and better define the activities that will occur throughout the project's entire life span.

1. *Planning*- First, you must look at the ICT needs of your organisation. These needs are determined during the planning phase of an IT project by using an information-gathering technique such as a questionnaire. Keep in mind that the objective must address and remedy an issue or a problem within the organisation or a target community. Once you define the objective, you can put an action plan into place.
2. *Analysis* - The analysis phase focuses on the functions the end system will need to perfc 49
Once you establish the performance needs, you will be able to develop and formalize a more detailed description of the system. The use of business, data, event, and process models during the analysis phase will ensure that both the development team and the end user are on the same track.

3. *Design*- The third phase of an IT project is the design phase. In it, the plan for the end system is developed. This plan should accurately define the implementation of the project without actually executing the project.

4. *Construction* - During the construction phase of the project, the ICT team actually constructs the project or system. Here, the team uses a process map that identifies the procedures that need to be completed to duplicate the agreed-upon plan.

5. *Testing*- The testing phase is about the most critical of all the ICT project phases. It is in this phase that the team determines which tests to implement to ensure that the system being produced will be of the highest quality.

6. *Rollout*– This is the final phase in an ICT project. It is here that the team begins the activities for releasing the finished product to the end user. Planning for the rollout activities can help the process progress more smoothly. For example, if another system is already in place, your team will need to thoroughly review the conversion process to ensure the smooth transition from the previous system to the new one.

3.3 Design and Communication of Research Proposals for ICT Projects

A Research Proposal is an expression of intent that a research should indeed take place. It is structured with ten elements contained therein. It is convincing as well as concise, rather than containing obscuring ideas amongst a plethora of excessive words and verbosity. Research proposal can be written for several purposes: academic, business, government etc. Depending on the purpose, there are variations in the composition or organisation of the research proposal.

3.3.1 Organisation of a Research Proposal for ICT Projects

A typical Research Proposal for an ICT Project is organized as follows:

Title of study– Explains the topic of the proposed research. You must keep it concise and make it attention catching.
Introduction –This part introduces the reader or audience to the proposed research. It usually begins with a brief historical overview of the topic. It should indicate what you are interested in the study.
Significance of Research – This part stipulates the purpose and significance of the research. It also states the wider implications of your study.
Literature Review– This part has four functions. First it focuses on what has been done before. Secondly it outlines the instruments to be used for the study. Thirdly, it indicates why it is necessary for you to embark on the research. Finally, it states the boundaries of your research, which is called delimitations of the research.
50 *odology* – This is composed of the research design and data analysis. Here, you outline the instruments you intend to use eg. interviews, surveys, content analysis, case studies, meta-analysis.
Expected Result – This area states the possible outcomes that are expected from the research
Ethical statement – In case the research requires human participants to be used, you may need to apply for ethical approval from your organisation or institutions involved.
Time frame / Budget – This part lists the time and dates for each programme of the research or activities to be accomplished. It also indicate sources of funding and how the funds will be used to implement the research.
References – This part contains all the resources consulted or to be consulted in the course of the research.

3.3.2Steps in Design of Research Proposals for ICT Projects

In research proposal for ICT projects, it is important that you outline the reasons why you are proposing a research and what process or procedures you will follow to complete the research. There are ten structured steps (also making up the important elements of) in designing a good research proposal for ICT Projects. These are:

1. Determining the general topic;
2. Performing a Literature review on the topic;
3. Identifying a gap in the literature;
4. Identifying a problem highlighted by the gap in the literature and framing a purpose for the study;
5. Writing an Introduction to the study;
6. Framing research hypotheses and or research questions to investigate or guide the study;
7. Determining the method of investigation
8. Outlining the research design
9. Defining the Sample size and the characteristics of the proposed sample;
10. Describing the procedures to follow for data collection and data analyses.

Determining the General Topic

The first step in writing a research proposal is to identify a general topic or subject area to investigate. Usually this first point is the easiest because the research proposal will be tied to the overall theme of the project. In such a case, the general subject for investigation may be determined by the sponsor of the research.

Performing a Literature Review on the Topic
The next step is to read as much literature on the general subject matter as time will allow. While you read the literature it is advised to take copious notes and then summarize the purpose and findings of each study relevant to the general subject matter of the eventual research proposal.

Identifying a Gap in the Literature
The general purpose of the literature review is not to have notes on a whole bunch of different journal articles and books on a particular subject. The purpose is to understand what studies have already been done on the subject and then to identify any glaring gaps in the literature. Identifying gaps in the literature will open up opportunities to add to the body of knowl 51 within the general subject area.

Identifying a Problem highlighted by the Gap in the Literature and Framing a Purpose for the Study
After you have performed the literature review and hopefully identified an obvious gap in the literature, next you need to identify a problem related to the gap and frame a purpose statement as to why you are investigating what you propose and why others should care about the study. If your readers cannot answer the question so what, or your answer to the question, why should I care, then it may be interesting to you, but not relevant to anyone else.

Writing an Introduction to the study
After you have identified a pertinent problem and framed a purpose statement, then you need to craft an introduction. Among other things, the introduction to the proposal should include:

- The Problem Statement
- A brief Summary of the literature
- A brief Description of the gap in the literature
- A Purpose statement as to why you are proposing the study and why others should be interested in the subject matter tied to your research proposal.

Framing Research Hypotheses and or Research Questions to Investigate or Guide the Study
The sixth step in designing a research proposal is to identify and craft carefully defined research hypotheses and or research questions. Research hypotheses identify what you are actually going to investigate and what you expect to find from your research study. Research hypotheses are normally found in quantitative research proposals which compare differences and/or relationships between independent variables (or causes of phenomena) and dependent variables (or the effects that result from causes). Research questions are normally found in qualitative research studies. Most importantly, in good academic writing, research hypotheses and questions must be informed or flow from the literature review.

Determining the Method of Investigation
This is the second of the two main parts of the research proposal. It is important to include a method or methodology section that outlines the procedures you will follow to complete your proposed research. The method section generally includes the following:

- Research design;
- Sample size and characteristics of the proposed sample;
- Data collection and data analysis procedures

Outlining the Research Design
This step is meant to outline the research design of the proposal. For each part of the design, it is highly advised that you describe two or three possible alternatives and then tell why you propose the particular design you chose. For instance, you might describe the differences between experimental, quasi-experimental, and non-experimental designs before you elaborate on why you propose a non-experimental design.

ning the Sample Size and the Characteristics of the Proposed Sample;
Here, you will describe the sample size and the characteristics of the participants in the sample size. Describe how you determined how many people to include in the study and what attributes they have which make them uniquely suitable for the study.

Describing the Procedures to follow for Data Collection and Data Analyses.
This is the last stepin the design of the research proposal of ICT projects. It contains the data collection and analysis procedures. In this section you will describe how you propose to collect your data e.g. through a questionnaire survey if you are performing a quantitative analysis or through one-on-one interviews if you are performing a qualitative or mixed methods study. After you collect the data, you also need to follow a scheme as how to analyze the data and report the results.

4.0 Conclusion
In this unit you have learnt about research proposals in ICT Projects and also how to design and communicate these proposals to an organisation.

5.0 Summary
In this unit, a research proposal is a document that is typically written by a scientist or academic which describes the ideas for an investigation on a certain topic. An ICT project can be described as a temporary endeavor in the field of ICT undertaken to create a unique product, service, or result. There are ten structured steps in designing a good research proposal for ICT Projects

6.0 Tutor-Marked Assignment
1. Explain briefly what research proposal is
2. Enumerate on the attributes of ICT projects
3. Itemize the steps in designing a research proposal for ICT projects

7.0 References/Further Readings
1. University of Illinois Library (2018). Writing a Research Proposal @ <http://guides.library.illinois.edu/c.php?g=504643&p=3454888#s-lg-box-10672847>
2. Bogra L. (2014). 5 Steps to a successful implementation of ICT Projects @ <https://www.linkedin.com/pulse/20140611182435-12732154-5-steps-to-a-successful-implementation-of-ict-projects/>

3. Faillot-Devarre M., (2014) ICT Project Management - Study Notes, SlideShare. @ <https://www.slideshare.net/MariusFaillotDevarre/ict-project-management-study-notes>
4. Ecoggins E. (2016), 10 Steps to Writing an Academic Research Proposal @ . <https://owlcation.com/academia/10-Steps-to-Writing-a-Research-Proposal#>

Module 4: ICT / Software Research Methodologies
Unit 1 Introduction to ICT / Software Research Methodologies
Unit 2 Traditional ICT / Software Methodologies.
Unit 3 Other Related (Non-Traditional) ICT / Software Methodologies

UNIT 1 INTRODUCTION TO ICT / SOFTWARE RESEARCH METHODOLOGIES

CONTENTS

1.0 INTRODUCTION

In this unit you will consider what ICT / Software Research Methodologies are. You will also learn the various types of ICT / Software Research Methodologies, including the traditional types and the other related types.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what ICT / Software Research Methodologies are
- list the various types of ICT / Software Research Methodologies.

3.0 MAIN CONTENT

3.1 What are ICT / Software Research Methodologies?

ICT Research Methodologies are the same software methodologies known as the Software Development Life Cycle, SDLC. So ICT Research Methodologies are the series of planned

activities to develop ICT Research Products. The main aim of ICT Research Methodologies is to produce high-quality ICT Research products that meets or exceeds user expectations, reaches completion within times and cost estimates.

The methodologies consist of a detailed plan describing how to develop, maintain, replace and alter or enhance specific ICT research product. The plan defines a methodology for improving the quality of a product and the overall development process. A typical ICT Research methodology is graphically represented by Figure 4.1 below.

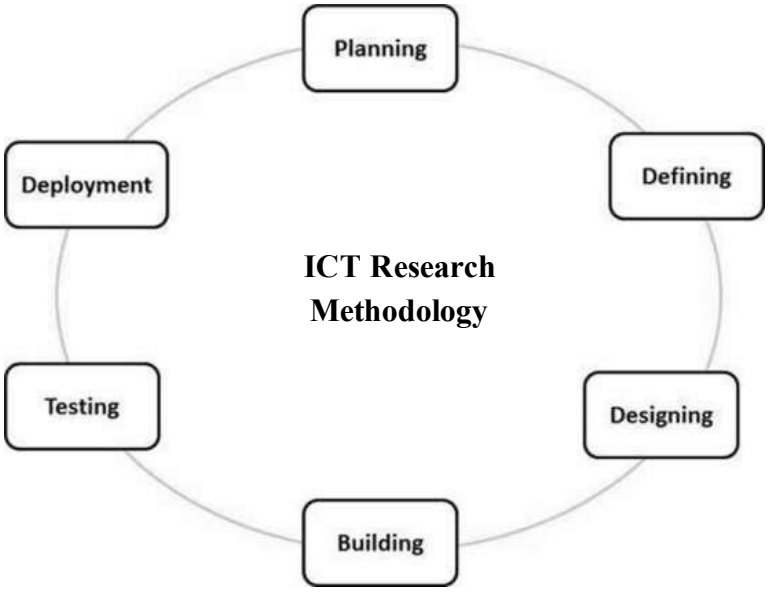


Figure 4.1: Graphical representation of the various stages of a typical ICT Research Methodology

3.2 Stages of ICT / Software Research Methodologies

A typical ICT / Software Research Methodology consists of the following stages −
Stage 1: Planning and Requirement Analysis
Stage 2: Defining Requirements
Stage 3: Designing the Product Architecture
Stage 4: Building or Developing the Product
Stage 5: Testing the Product
Stage 6: Deployment in the Market and Maintenance

3.2.1 Stage 1: Planning and Requirement Analysis

Requirement analysis is the most important and fundamental stage in the methodology. It is performed by the senior members of the development team. This information is then used to plan the basic development approach and to conduct product feasibility study in the economical, operational and technical areas.

Planning for the quality assurance requirements and identification of the risks associated with the research project is also done in the planning stage. The outcome of the technical feasibility study is to define the various technical approaches that can be followed to implement the project successfully with minimum risks.

3.2.2 Stage 2: Defining Requirements

Once the requirement analysis is done the next step is to clearly define and document the research product requirements. For software development, this is done through an **SRS (Software Requirement Specification)** document which consists of all the product requirements to be designed and developed during the project life cycle.

3.2.3 Stage 3: Designing the Product Architecture

Stage 2 is the reference for product architects to come out with the best architecture for the research product to be developed. Based on the requirements specified in Stage 2, usually more than one design approach for the product architecture is proposed and documented in a DDS - Design Document Specification.

This DDS is reviewed by all the important stakeholders and based on various parameters as risk assessment, product robustness, design modularity, budget and time constraints, the best design approach is selected for the product.

3.2.4 Stage 4: Building or Developing the Product

In this stage, the actual development starts and the research product is built. The programming code is generated as per DDS during this stage. If the design is performed in a detailed and organized manner, code generation can be accomplished without much hassle.

Developers must follow the coding guidelines defined by their organization and programming tools like compilers, interpreters, debuggers, etc. are used to generate the code. Different high level programming languages such as C, C++, Pascal, Java and PHP are used for coding. The programming language is chosen with respect to the type of product being developed.

3.2.5 Stage 5: Testing the Product

This stage is usually a subset of all the stages as in the modern SDLC models, the testing activities are mostly involved in all the stages of SDLC. However, this stage refers to the testing only stage of the product where product defects are reported, tracked, fixed and retested, until the product reaches the quality standards defined in the SRS.

3.2.6 Stage 6: Deployment in the Market and Maintenance

Once the product is tested and ready to be deployed it is released formally. Sometimes product deployment happens in stages depending on organization’s strategy or style. The product may first be released in a limited segment and tested in the real business environment (UAT- User acceptance testing).

Then based on the feedback, the product may be finally released as it is or with suggested enhancements. After the product is released, its maintenance is done continuo

3.3 Types of ICT / Software Research Methodologies

There are various ICT / Software Research Methodologies or models defined and designed which are followed during the research methodology process. These methodologies are also referred as Software Development Process Models. Each process model follows a Series of steps unique to its type to ensure success in the process of software development. They are generally divided into two main groups: the traditional ICT / Software Research Methodologies Group and the Other related Group.

56

The Traditional ICT / Software Research models are the following −

- Waterfall Model
- Iterative Model
- Spiral Model
- V-Model
- Big Bang Model

The Other related methodologies are –

- Agile Model
- RAD Model
- Rapid Application Development and
- Prototyping Models.

4.0 Conclusion

In this unit you have studied ICT / Software Research Methodologies. You also learnt their various model types, both the core group types and the other related types.

5.0 Summary

In this unit, ICT Research Methodologies are the series of planned activities to develop ICT Research Products. They consist of a detailed plan describing how to develop, maintain, replace and alter or enhance specific ICT research product. The plan defines a methodology for improving the quality of a product and the overall development process.

6.0 Tutor-Marked Assignment

1. What are ICT / Software Research Methodologies?
2. Itemize the traditional group types of ICT / Software Research Methodologies
3. List the other related types of ICT / Software Research Methodologies

7.0 References/Further Readings

1. Wikipaedia (2020). Software Development Process @ < https://en.wikipedia.org/wiki/Software_development_process#Agile_development >
2. Tutorialspoint (2020). SDLC Overview @ https://www.tutorialspoint.com/sdlc/sdlc_overview.htm
3. Suryanarayana, Girish (2015). "Software Process versus Design Quality: Tug of War?". IEEE Software. 32 (4): 7–11. doi:10.1109/MS.2015.87.

4. Whitten, Jeffrey L.; Lonnie D. Bentley, Kevin C. Dittman. (2003). Systems Analysis and Design Methods. 6th edition. ISBN 0-256-19906-X.
5. Barry Boehm (1996)., "A Spiral Model of Software Development and Enhancement". In: ACM SIGSOFT Software Engineering Notes (ACM) 11(4):14-24, August 1986

UNIT 2 TRADITIONAL ICT / SOFTWARE METHODOLOGIES

CONTENTS

1.0 INTRODUCTION

In this unit you will consider the core ICT / Software Research Methodologies. You will learn each type and its peculiarity.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain each of the traditional ICT / Software Research Methodologies
- comparatively describe each methodology as a model in ICT Research methodology.

3.0 MAIN CONTENT

3.1 Waterfall Model

The Waterfall Model was the first Research Process Model to be introduced. It is also referred to as a linear-sequential life cycle model. It is very simple to understand and use. In a waterfall model, each phase must be completed before the next phase can begin and there is no overlapping in the phases.

In "The Waterfall" approach, the whole process of research product development is divided into separate phases. In this Waterfall model, typically, the outcome of one phase acts as the input for the next phase sequentially.

The illustration in Figure 4.2 is a representation of the different phases of the Waterfall Model.

3.1.1 Sequential Phases in Waterfall Model

The Sequential Phases in Waterfall Model are −

Requirement Gathering and analysis − All possible requirements of the system to be developed are captured in t

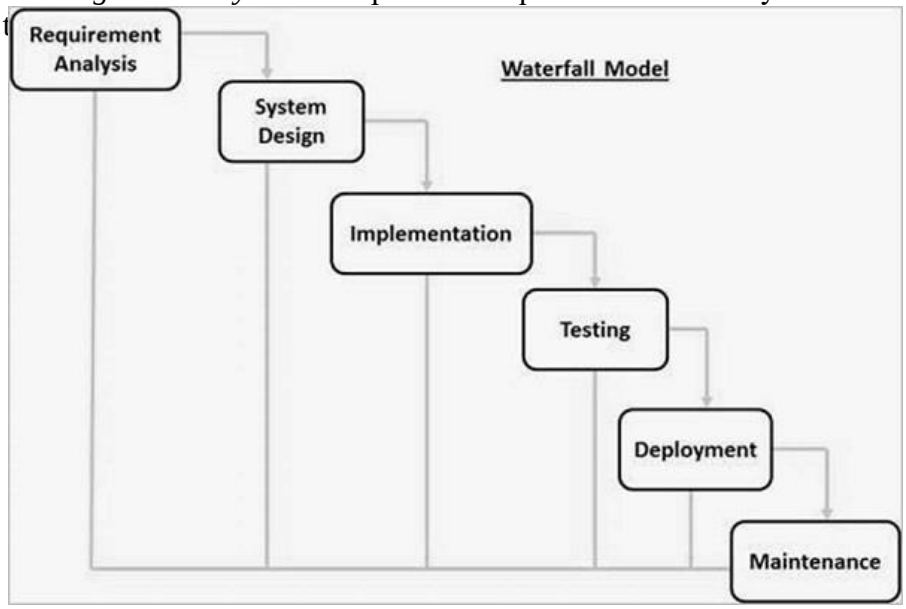


Figure 4.2: The Waterfall Model of ICT Research Methodology

System Design − The requirement specifications from first phase are studied in this phase and the system design is prepared. This system design helps in specifying hardware and system requirements and helps in defining the overall system architecture.

Implementation − With inputs from the system design, the system is first developed in small programs called units, which are integrated in the next phase. Each unit is developed and tested for its functionality, which is referred to as Unit Testing.

Integration and Testing − All the units developed in the implementation phase are integrated into a system after testing of each unit. Post integration the entire system is tested for any faults and failures.

Deployment of system − Once the functional and non-functional testing is done; the product is deployed in the customer environment or released into the market.

Maintenance − There are some issues which come up in the client environment. To fix those issues, patches are released. Also to enhance the product some better versions are released. Maintenance is done to deliver these changes in the customer environment.

All these phases are cascaded to each other in which progress is seen as flowing steadily downwards (like a waterfall) through the phases. The next phase is started only after the defined set of goals are achieved for previous phase and it is signed off, so the name "Waterfall Model". In this model, phases do not overlap.

3.1.2 Advantages of Waterfall Model

The main advantages of waterfall development are that it allows for departmentalization and control.

Some of the major advantages of the Waterfall Model are as follows −

- Simple and easy to understand and use
- Easy to manage due to the rigidity of the model. Each phase has specific deliverables and a review process.
- Phases are processed and completed one at a time.
- It works well for smaller projects where requirements are very well understood.
- It has clearly defined stages.
- Well understood milestones.
- Easy to arrange tasks.
- Process and results are well documented.

3.1.3 Disadvantages of Waterfall Model

The main disadvantage of waterfall development is that it does not allow much reflection or revision.

The major disadvantages of the Waterfall Model are as follows −

- No working software is produced until late during the life cycle.
- High amounts of risk and uncertainty.
- Not a good model for complex and object-oriented projects.
- Poor model for long and ongoing projects.
- Not suitable for the projects where requirements are at a moderate to high risk of changing. So, risk and uncertainty is high with this process model.
- It is difficult to measure progress within stages.
- Cannot accommodate changing requirements.
- Adjusting scope during the life cycle can end a project.
- Integration is done as a "big-bang. at the very end, which doesn't allow identifying any technological or business bottleneck or challenges early.

3.2 Iterative Model

In the Iterative model, iterative process starts with a simple implementation of a small set of the product requirements and iteratively enhances the evolving versions until the complete system is implemented and ready to be deployed.

Iterative process starts with a simple implementation of a subset of the product requirements and iteratively enhances the evolving versions until the full system is implemented. At each iteration, design modifications are made and new functional capabilities are added. The basic idea behind this method is to develop a system through repeated cycles (iterative) and in smaller portions at a time (incremental).

The illustration in Figure 4.3 is a representation of the Iterative and Incremental model −

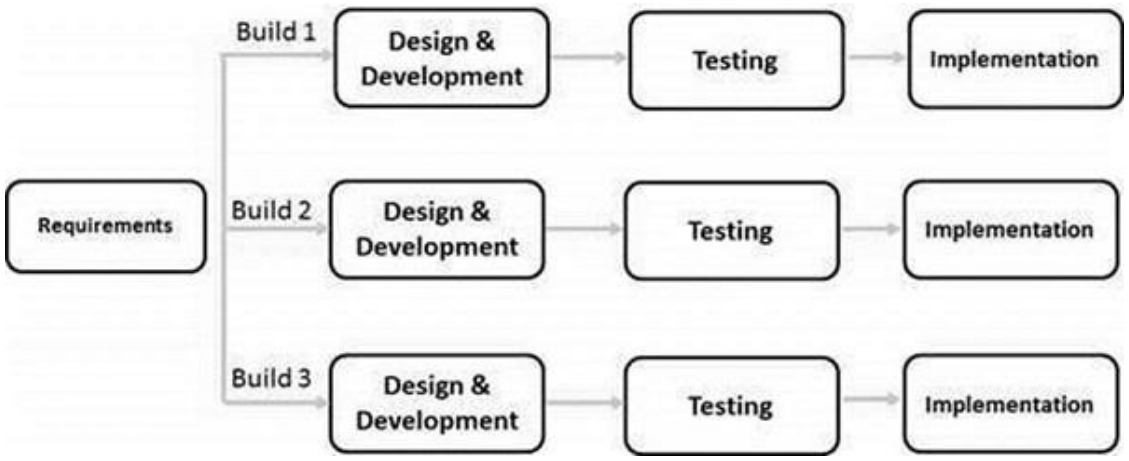


Figure 4.3: The Iterative and Incremental model of ICT Research Methodology

3.2.1 Advantages of Iterative Model

The main advantage of this model is that there is a working model of the system at a very early stage of development, which makes it easier to find functional or design flaws. Finding issues at an early stage of development enables to take corrective measures in a limited budget.

The advantages of the Iterative Model are as follows −

- Some working functionality can be developed quickly and early in the life cycle.
- Results are obtained early and periodically.
- Parallel development can be planned.
- Progress can be measured.
- Less costly to change the scope/requirements.
- Testing and debugging during smaller iteration is easy.
- Risks are identified and resolved during iteration; and each iteration is an easily managed milestone.
- Easier to manage risk - High risk part is done first.

- With every increment, operational product is delivered.
- Issues, challenges and risks identified from each increment can be utilized/applied to the next increment.
- Risk analysis is better.
- It supports changing requirements.
- Initial Operating time is less.
- Better suited for large and mission-critical projects.
- During the life cycle, software is produced early which facilitates customer evaluation and feedback.

3.2.2 Disadvantages of Iterative Model -

The disadvantage with this model is that it is applicable only to large and bulky development projects. This is because it is hard to break a small system into further small serviceable increments/modules.

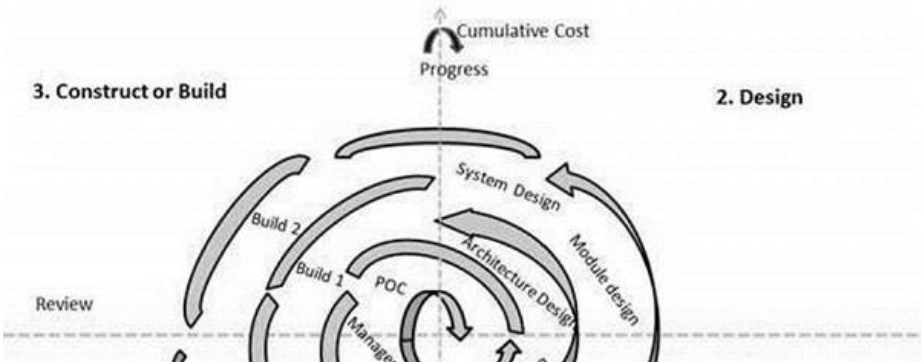
The disadvantages of the Iterative and Incremental Model are as follows −

- More resources may be required.
- Although cost of change is lesser, but it is not very suitable for changing requirements.
- More management attention is required.
- System architecture or design issues may arise because not all requirements are gathered in the beginning of the entire life cycle.
- Defining increments may require definition of the complete system.
- Not suitable for smaller projects.
- Management complexity is more.
- End of project may not be known which is a risk.
- Highly skilled resources are required for risk analysis.
- Projects progress is highly dependent upon the risk analysis phase.

3.3 Spiral Model

The spiral model combines the idea of iterative development with the systematic, controlled aspects of the waterfall model. It allows incremental releases of the product or incremental refinement through each iteration around the spiral.

The spiral model has four phases. An ICT research project repeatedly passes through these phases in iterations called Spirals. These phases are: Identification, Design, Construct or Build, and Evaluation and Risk Analysis. The following illustration in Figure 4.4 is a representation of the Spiral Model, listing the activities in each phase.



3. 62 **dvantages of Spiral Model**

The main advantage of spiral lifecycle model is that it allows elements of the product to be added in, when they become available or known. This assures that there is no conflict with previous requirements and design.

The advantages of the Spiral Model are as follows −

- Changing requirements can be accommodated.
- Allows extensive use of prototypes.
- Requirements can be captured more accurately.
- Users see the system early.
- Development can be divided into smaller parts and the risky parts can be developed earlier which helps in better risk management.

3.3.2 Disadvantages of Spiral Model

- The disadvantages of the Spiral Model are as follows −
- Management is more complex.
- End of the project may not be known early.
- Not suitable for small or low risk projects and could be expensive for small projects.
- Process is complex
- Spiral may go on indefinitely.
- Large number of intermediate stages requires excessive documentation.

3.4 V-Model

The V-model is a model where execution of processes happens in a sequential manner in a V-shape. It is also known as Verification and Validation model. The V-Model is an extension of the waterfall model and is based on the association of a testing phase for each corresponding development stage. This means that for every single phase in the development cycle, there is a

directly associated testing phase. This is a highly-disciplined model and the next phase starts only after completion of the previous phase.

There are three groups of phases in the V-Model. These are the Verification phases composed of: Business Requirement Analysis, System Design, Architectural Design, Module Design; the Coding Phase; and the Validation Phases composed of: Unit Testing, Integration Testing, System Testing, and Acceptance Testing.

The following illustration in Figure 4.5 depicts the different phases in a V-Model of the SDLC.

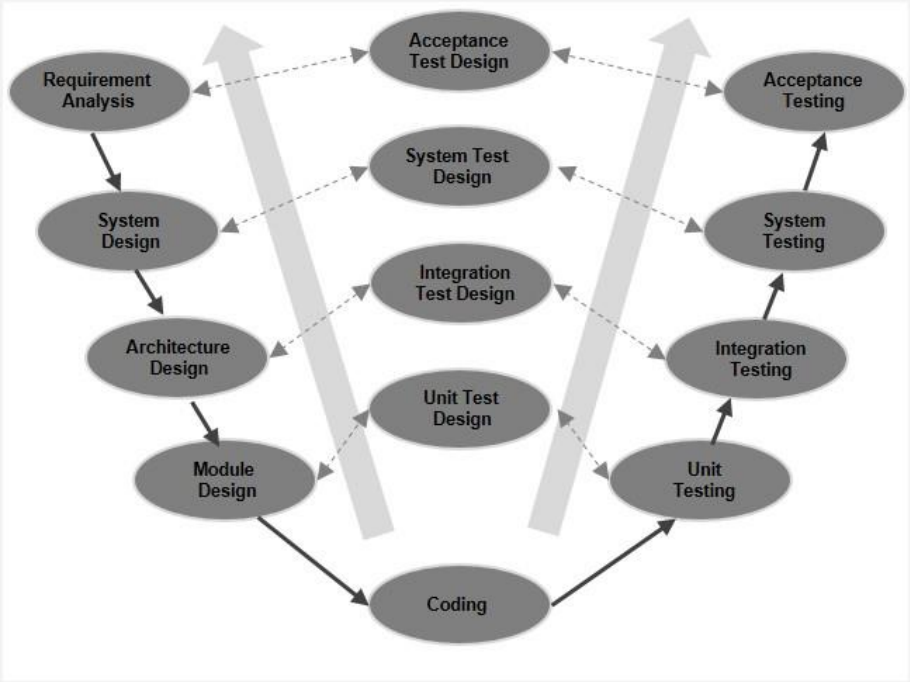


Figure 4.5: The V-model of ICT Research Methodology

3.4.1 Advantages of V-Model

The main advantage of the V-Model method is that it is very easy to understand and apply. The simplicity of this model also makes it easier to manage.

The advantages of the V-Model method are as follows −

- This is a highly-disciplined model and Phases are completed one at a time.
- Works well for smaller projects where requirements are very well understood.
- Simple and easy to understand and use.

- Easy to manage due to the rigidity of the model. Each phase has specific deliverables and a review process.

3.4.2 Disadvantages of V-Model

The main disadvantage of V-model is that the model is not flexible to changes and just in case there is a requirement change, which is very common in today's dynamic world, it becomes very expensive to make the change.

The disadvantages of the V-Model method are as follows −

- High risk and uncertainty.
- Not a good model for complex and object-oriented projects.
- Poor model for long and ongoing projects.
- Not suitable for the projects where requirements are at a moderate to high risk of changing.
- Once an application is in the testing stage, it is difficult to go back and change a functionality.
- No working software is produced until late during the life cycle.

3.5 Big Bang Model

The Big Bang model is a model where we do not follow any specific process. The development just starts with the required funds and efforts as the input, and the output is the research product developed which may or may not be as per customer requirement.

The Big Bang Model comprises of focusing all the possible resources in the research product development and coding, with very little or no planning. The requirements are understood and implemented as they come. Any changes required may or may not need to revamp the complete software.

3.5.1 Advantages of Big Bang Model

The main advantage of the Big Bang Model is that it is very simple and requires very little or no planning. Easy to manage and no formal procedure are required.

The advantages of the Big Bang Model are as follows −

- This is a very simple model
- Little or no planning required
- Easy to manage
- Very few resources required
- Gives flexibility to developers
- It is a good learning aid for new comers or students.

3.5.2 Disadvantages of Big Bang Model

The main disadvantage of the Big Bang Model is that it's a very high risk model and changes in the requirements or misunderstood requirements may even lead to complete reversal or scraping of the project.

The disadvantages of the Big Bang Model are as follows −

- Very High risk and uncertainty.
- Not a good model for complex and object-oriented projects.
- Poor model for long and ongoing projects.
- Can turn out to be very expensive if requirements are misunderstood.

4.0 Conclusion

In this unit you have studied the traditional ICT / Software Research Methodologies. You also learnt their various model types, with their similarities and differences among themselves.

5.0 Summary

In this unit, the traditional ICT Research Methodologies are the series of commonly used ICT Research Products. They consist of a detailed plan describing how to develop, maintain, replace and alter or enhance specific ICT research product. The Traditional ICT / Software Research models include: Waterfall Model, Iterative Model, Spiral Model, V-Model and Big Bang Model

6.0 Tutor-Marked Assignment

1. What are the traditional ICT / Software Research Methodologies?
2. Itemize each traditional group types of ICT / Software Research Methodologies and connect how they are related.

7.0 References/Further Readings

1. Wikipaedia (2020). Software Development Process @ < https://en.wikipedia.org/wiki/Software_development_process#Agile_development >
2. Tutorialspoint (2020). SDLC Overview @ https://www.tutorialspoint.com/sdlc/sdlc_overview.htm
3. Suryanarayana, Girish (2015). "Software Process versus Design Quality: Tug of War?". IEEE Software. 32 (4): 7–11. doi:10.1109/MS.2015.87.
4. Whitten, Jeffrey L.; Lonnie D. Bentley, Kevin C. Dittman. (2003). Systems Analysis and Design Methods. 6th edition. ISBN 0-256-19906-X.

UNIT 3 OTHER RELATED (NON-TRADITIONAL) ICT / SOFTWARE METHODOLOGIES

CONTENTS

1.0 INTRODUCTION

In this unit you will consider the other related (non-traditional) ICT / Software Research Methodologies. You will also learn each type comparative to the traditional type.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain each of the non- traditional ICT / Software Research Methodologies
- describe each methodology comparatively to a given traditional type.

3.0 MAIN CONTENT

3.1 Agile Model

Agile model is a combination of iterative and incremental process models with focus on process adaptability and user satisfaction by rapid delivery of working product. Agile Methods break the product into small incremental builds. These builds are provided in iterations. Each iteration typically lasts from about one to three weeks.

A graphical illustration of the Agile Model is shown in Figure 4.6

3.1.1 Agile Model Vs Traditional Models

Agile is based on the adaptive product development methods, whereas the traditional models like the waterfall model is based on a predictive approach. Predictive teams in the traditional models usually work with detailed planning and have a complete forecast of the exact tasks and features to be delivered in the next few months or during the product life cycle.

Predictive methods entirely depend on the requirement analysis and planning done in the beginning of cycle. Any changes to be incorporated go through a strict change control management and prioritization.

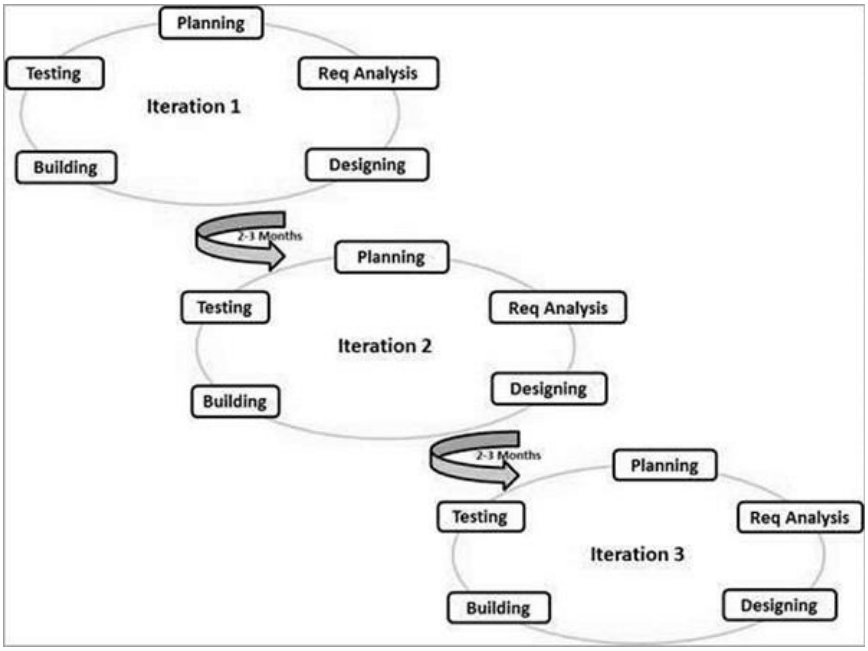


Figure 4.6: The Agile model of ICT Research Methodology

Agile uses an adaptive approach where there is no detailed planning and there is clarity on future tasks only in respect of what features need to be developed. There is feature driven development and the team adapts to the changing product requirements dynamically. The product is tested very frequently, through the release iterations, minimizing the risk of any major failures in future.

3.1.2 Advantages of Agile Model

Agile methods are being widely accepted in the software world recently.
The advantages of the Agile Model are as follows −

- Is a very realistic approach to software development.
- Promotes teamwork and cross training.
- Functionality can be developed rapidly and demonstrated.
- Resource requirements are minimum.
- Suitable for fixed or changing requirements
- Delivers early partial working solutions.
- Good model for environments that change steadily.
- Minimal rules, documentation easily employed.
- Enables concurrent development and delivery within an overall planned context.
- Little or no planning required.
- Easy to manage.
- Gives flexibility to developers.

68

3.1.3 Disadvantages of Agile Model

The disadvantages of the Agile Model are as follows −

- Not suitable for handling complex dependencies.
- More risk of sustainability, maintainability and extensibility.
- An overall plan, an agile leader and agile PM practice is a must without which it will not work.
- Strict delivery management dictates the scope, functionality to be delivered, and adjustments to meet the deadlines.
- Depends heavily on customer interaction, so if customer is not clear, team can be driven in the wrong direction.
- There is a very high individual dependency, since there is minimum documentation generated.

- Transfer of technology to new team members may be quite challenging due to lack of documentation.

3.2 RAD Model

The RAD (Rapid Application Development) is based on prototyping and iterative development with no specific planning involved. The writing process itself involves the planning required for developing the product. RAD focuses on gathering user requirements through workshops or focus groups, early testing of the prototypes by the user using iterative concept, reuse of the existing prototypes (components), continuous integration and rapid delivery.

In the RAD model, the functional modules are developed in parallel as prototypes and are integrated to make the complete product for faster product delivery. Since there is no detailed preplanning, it makes it easier to incorporate the changes within the development process. RAD

projects follow iterative and incremental model and have small teams comprising of developers, domain experts, customer representatives and other IT resources working progressively on their component or prototype.

The most important aspect for this model to be successful is to make sure that the prototypes developed are reusable.

Figure 4.7 shows the various phases of a typical RAD Model: Business Modeling, Data Modeling, Process Modeling, Application Generation, Testing and Turnover

3.2.1 RAD Model Vs Traditional Models

The traditional models follow a rigid process models with high emphasis on requirement analysis and gathering before the coding starts. It puts pressure on the customer to sign off the requirements before the project starts and the customer doesn't get the feel of the product as there is no working build available for a long time.

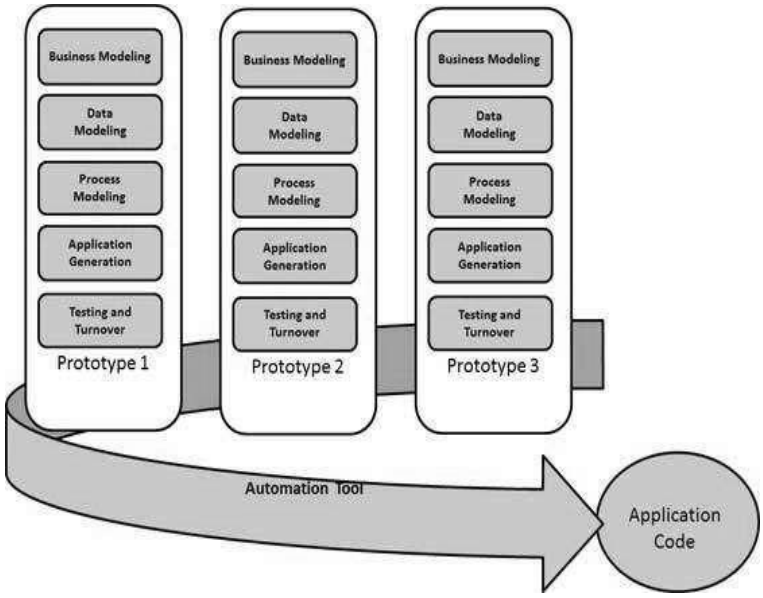


Figure 4.7: Graphical representation of the RAD (Rapid Application Development) Model

The RAD model focuses on iterative and incremental delivery of working models to the user. This results in rapid delivery to the user and user involvement during the complete development cycle of product reducing the risk of non-conformance with the actual user requirements.

3.2.2 Advantages of RAD Model

The main advantage of RAD model is that it enables rapid delivery as it reduces the overall development time due to the reusability of the components and parallel development. RAD works well only if high skilled engineers are available and the user is also committed to achieve the targeted prototype in the given time frame.

The advantages of the RAD Model are as follows −

- Changing requirements can be accommodated.
- Progress can be measured.
- Iteration time can be short with use of powerful RAD tools.
- Productivity with fewer people in a short time.
- Reduced development time.
- Increases reusability of components.
- Quick initial reviews occur.
- Encourages customer feedback.
- Integration from very beginning solves a lot of integration issues.

3.2.3 Disadvantages of RAD Model

The main disadvantage of RAD model is that if there is commitment lacking on either side the model may fail.

70

The disadvantages of the RAD Model are as follows −

- Dependency on technically strong team members for identifying business requirements.
- Only system that can be modularized can be built using RAD.
- Requires highly skilled developers/designers.
- High dependency on modeling skills.
- Inapplicable to cheaper projects as cost of modeling and automated code generation is very high.
- Management complexity is more.
- Suitable for systems that are component based and scalable.
- Requires user involvement throughout the life cycle.
- Suitable for project requiring shorter development times.

3.3 Prototyping Models.

The Prototyping refers to building application prototypes which displays the functionality of the product under development, but may not actually hold the exact logic of the original software.

Prototyping model is becoming very popular as a research development model, as it enables to understand user requirements at an early stage of development. It helps get valuable feedback from the user and helps research designers and developers understand about what exactly is expected from the product under development.

Prototyping is used to allow the users evaluate developer proposals and try them out before implementation. It also helps understand the requirements which are user specific and may not have been considered by the developer during product design.

3.3.1 Stepwise Approaches to Design a Prototype.

Basic Requirement Identification - This step involves understanding the very basics product requirements especially in terms of user interface. The more intricate details of the internal design and external aspects like performance and security can be ignored at this stage.

Developing the initial Prototype - The initial Prototype is developed in this stage, where the very basic requirements are showcased and user interfaces are provided. These features may not exactly work in the same manner internally in the actual software developed. While, the work arounds are used to give the same look and feel to the customer in the prototype developed.

Review of the Prototype - The prototype developed is then presented to the customer and the other important stakeholders in the project. The feedback is collected in an organized manner and used for further enhancements in the product under development.

Revise and Enhance the Prototype - The feedback and the review comments are discussed during this prototype and some negotiations happen with the user based on factors like – time and budget constraints and technical feasibility of the actual implementation. The changes accepted are again incorporated in the new Prototype developed and the cycle repeats until the user expectations are met.

3.3.2 Dimensions of a Prototype.

Prototypes can have horizontal or vertical dimensions. A Horizontal prototype displays the user interface for the product and gives a broader view of the entire system, without concentrating on internal functions. The purpose of a horizontal prototype is to get more information on the user interface level and the business requirements. It can even be presented in the sales demos to get business in the market.

A Vertical prototype on the other side is a detailed elaboration of a specific function or a sub system in the product. Vertical prototypes are technical in nature and so their purpose are to get details of the exact functioning of the sub systems. For example, database requirements, interaction and data processing loads in a given sub system.

3.3.3 Advantages of Prototyping

The advantages of the Prototyping Model are as follows −

- Increased user involvement in the product even before its implementation.
- Since a working model of the system is displayed, the users get a better understanding of the system being developed.
- Reduces time and cost as the defects can be detected much earlier.

- Quicker user feedback is available leading to better solutions.
- Missing functionality can be identified easily.
- Confusing or difficult functions can be identified.

3.3.4 Disadvantages of Prototyping

The Disadvantages of the Prototyping Model are as follows −

- Risk of insufficient requirement analysis owing to too much dependency on the prototype.
- Users may get confused in the prototypes and actual systems.
- Practically, this methodology may increase the complexity of the system as scope of the system may expand beyond original plans.
- Developers may try to reuse the existing prototypes to build the actual system, even when it is not technically feasible.
- The effort invested in building prototypes may be too much if it is not monitored properly.

4.0 Conclusion

In this unit you have studied the other (non-traditional) ICT / Software Research Methodologies. You also learnt how they compared to the traditional types.

5.0 Summary

In this unit, the ICT Research Methodologies other than the traditional types are the series of planned activities to develop ICT Research Products in ways that are not peculiar to the traditional format. Though, they still consist of a detailed plan describing how to develop, maintain, replace and alter or enhance the non-traditional ICT research products.

6.0 Tutor-Marked Assignment

1. List the ICT / Software Research Methodologies other than the traditional types
2. Comparatively analyze each non-traditional ICT / Software Research Methodology with respect to one traditional type.

7.0 References/Further Readings

1. Wikipaedia (2020). Software Development Process @ < https://en.wikipedia.org/wiki/Software_development_process#Agile_development >
2. Tutorialspoint (2020). SDLC Overview @ https://www.tutorialspoint.com/sdlc/sdlc_overview.htm
3. Suryanarayana, Girish (2015). "Software Process versus Design Quality: Tug of War?". IEEE Software. 32 (4): 7–11. doi:10.1109/MS.2015.87.
4. Barry Boehm (1996)., "A Spiral Model of Software Development and Enhancement". In: ACM SIGSOFT Software Engineering Notes (ACM) 11(4):14-24, August 1986

Module 5: Ethical Issues in ICT Research

Unit 1 Ethical Issues Involved in Planning, Conducting and Reporting of ICT Research
Unit 2 Application of Concepts and Critical Engagement with Issues Relating to Personal Research Needs
Unit 3 Assessment Items Related to Personal Research Topic

UNIT 1 ETHICAL ISSUES INVOLVED IN PLANNING, CONDUCTING AND REPORTING OF ICT RESEARCH

CONTENTS

1.0 INTRODUCTION

In this unit you will consider the general principles on ethical issues in ICT research. You will also learn the ethical principles guiding ICT research and the ethical issues involved in planning, conducting and reporting ICT research.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what the general principles on ethical issues in ICT research are
- discuss the ethical principles guiding ICT research and
- discuss the ethical issues involved in planning, conducting and reporting ICT research.

3.0 MAIN CONTENT

All researchers are faced with time-driven competitive pressures to research and publish, to achieve tenure, and some to deliver on grant funding proposals. However, those conducting ICT research face a different brand of pressure that can impact research ethics risks. And invariably, the rapid pace of transformations in information and communication technology and infrastructure that have catalyzed changes in research substance and mechanics has not been followed by institutionalized guidance on the protection of research subjects.

3.1 General Principles on Ethical Issues in ICT

ICT now influences the way we live, work, socialize, learn, interact, and relax. We expect the information on which we rely to be correct. The integrity of such information relies upon the development and operation of computer based information systems. Those who undertake the ng, development and operation of these information systems have obligations to assure information integrity and overall contribute to the public good.

It has been said that the potential benefit of the Information and Communication Technology society is being devalued by antisocial behaviour such as unauthorised access, information hacking, theft of electronic property, launching of viruses, identity theft, spam, electronic snooping and aggressive electronic marketing, cybercrimes, racism and harassment. Given these, it is obvious that this new ICT society is not problem-free. Such issues raise new ethical, cultural, economic and legal questions.

It is even questionable whether legal or technological counter measures are and ever will be very effective in combating the ever changing antisocial behaviour in the ICT Society. The absence of effective formal legal or technological controls presents grave dangers for everybody. Even at that with controls yet to effectively implemented, ICT has moved on and facilitated new ethical issues. Thus, in the absence of effective controls, the ICT society relies upon ethics coupled with education and awareness to reduce, if not eliminate, the ICT antisocial behaviours. The general principles on ethical issues in ICT shall be considered with respect to: ICT practice, ICT application development and ICT professionalism.

3.1.1 ICT Practice

The ethical dimension of the ICT practice has two distinct elements:

- process
- product.

Process concerns the activities of ICT professionals when undertaking research, development and service/product delivery. The ethical focus is professional conduct. It is this focus which is typically addressed by professional bodies in their codes of conduct. In other words a

professional knows that an action is the right thing to do in the circumstances and does it for the right motive.

Product concerns the outcome of professional ICT endeavour. One of the issues of ICT is to avoid systems being used for inappropriate secondary reasons, for example, a security system which has been implemented to reduce the risk of property theft being used additionally to monitor employee movement. Another issue is the thirst of the ICT industry to add more and more facilities in future system releases. Both issues are illustrations of unwarranted function creep. One final issue regarding product has to do with the increasing use of non-human agents based on complex systems.

3.1.2 ICT Application Development

ICT applications are about satisfying a particular requirement or need so that people can realize for example some economic, social and/or leisure objective. Consideration of stakeholders should not be limited to those who are financing the development project or politically influential or using the developed information system but broadened to be consistent with models of ethical analysis. Stakeholder must include individuals or groups who may be directly or indirectly affected by the information system and thus have a stake in the development activities. For example, anyone who suffers identity theft through a security flaw in an information system stakeholder.

Information systems developers must guard against the design principles where users must adapt to ICT rather than ICT being molded to users. The Design for All (DfA) approach is a way forward. This is because DfA's perspective is one of individualism and acceptability. DfA principles must focus on understanding the potential impact on people. It is suggested that providing designers with ethical or moral guidelines will prevent undesired ethical impacts in ICT product development.

3.1.3 ICT Professionalism

ICT professionals have specialized knowledge and often have positions with authority and respect in the community. Their professional activity spans the management, development and operation of all kinds of applications. For this reason, they are able to have a significant impact upon the world, including many of the things that people value. Along with such power to change the world comes the duty to exercise that power in a socially responsible manner.

3.1.4 Social Responsibility Principles and Ethics within ICT

There are six social responsibility principles that establish an ethos of professionalism within ICT. These principles are as the following:

- Develop a socially responsible culture within work which nurtures moral individual action
- Consider and support the wellbeing of all stakeholders
- Account for global common values and local cultural differences
- Recognizing social responsibility is beyond legal compliance and effective fiscal management

- Ensure all business processes are considered from a social responsibility perspective
- Be proactive rather than reactive.

Adherence to such principles as above can be problematic because of ICT professional relationships. ICT professionals find themselves in a variety of professional relationships with other people, including: employer-to-employee; client-to-professional; professional-to-professional; and society-to-professional. These relationships involve a diversity of interests, and sometimes these interests can come into conflict with each other. Socially responsible ICT professionals, therefore, have to be aware of possible conflicts of interest and try to avoid them so as to adhere to the six principles.

In line with the six social responsibility general principles above, specific guidance has been provided in the codes of conduct of national / international professional bodies such as the British Computer Society (BCS), the Australian Computer Society (ACS), the Association of Computing Machinery (ACM) and the influential Software Engineering Code of Ethics and Professional. In addition to such codes, professional bodies like Computer Professionals (Registration Council) of Nigeria (CPN) and Nigeria Computer Society (NCS) have established
 culum guidelines and accreditation requirements to help ICT professionals understand and manage ethical responsibilities.

3.2 Ethical Principles Guiding ICT Research: The Menlo Report

The Menlo report proposes a framework for ethical guidelines for computer and information security research, based on the principles set forth in the 1979 Belmont Report. The Belmont report is a seminal guide for ethical research in the biomedical and behavioral sciences. Three of the four core ethical principles of the Menlo report were derived from the Belmont Report. These are Respect for Persons, Beneficence, and Justice. The fourth ethical principle is Respect for Law and Public Interest.

The Menlo Report is a report published by the U.S. Department of Homeland Security Science & Technology Directorate, Cyber Security Division that outlines an ethical framework for research involving Information and Communications Technologies (ICT). It is a 17-page report, published on August 3, 2012. The following year, the Department of Homeland Security published a 33-page Companion report that includes case studies that illustrate how the principles can be applied.

The Menlo Report illustrates the application of these principles to information systems security research – a critical infrastructure priority with broad impact and demonstrated potential for widespread harm – although we expect the proposed framework to be relevant to other disciplines, including those targeted by the Belmont report but now operating in more complex and interconnected contexts. Overall, the intent of the Menlo report is to help clarify how the characteristics of ICT raise new potential for harm and to show how a reinterpretation of ethical principles and their application can lay the groundwork for ethically defensible research.

3.2.1 Principles of the Menlo Report

The Menlo Report attempts to summarize a set of basic principles to guide the identification and resolution of ethical problems arising in research of or involving ICT. The four core ethical principles of the Menlo report are itemized below.

1. Respect for Persons.
Participation as a research subject is voluntary, and follows from informed consent; Treat individuals as autonomous agents and respect their right to determine their own best interests; Respect individuals who are not targets of research yet are impacted; Individuals with diminished autonomy, who are incapable of deciding for themselves, are entitled to protection.

2. Beneficence.
Do not harm; Maximize probable benefits and minimize probable harms; Systematically assess both risk of harm and benefit.

3. Justice.
Each person deserves equal consideration in how to be treated, and the benefits of research should be fairly distributed according to individual need, effort, societal contribution, and merit; Selection of subjects should be fair, and burdens should be allocated equitably across impa 77 subjects.

4. Respect for Law and Public Interest.
Engage in legal due diligence and be transparent in methods and results. Be accountable for actions.

3.3 Ethical Issues Involved in Planning, Conducting and Reporting ICT Research

Ethical issues arise throughout any piece of research, starting form planning, through conducting the research to reporting the research. There are also close links between ethical concerns and issues around participation. Ethical issues also shade into questions of trust: since 'the researcher is the research instrument' in some important ways, the reader and/or user of qualitative research needs to be able to trust the researcher to have followed the appropriate procedures.

The key ethical concerns in the planning, conducting and reporting stages of the research are with particular reference to the following:

- Informed consent: when it's essential, how it's gathered, benefits and cost of written consent, and when it's used
- Harm to respondents
- Uses of anonymous data and maintenance of confidentiality
- Reciprocity in research relationships
- Reflexivity and ethics

Informed Consent
Informed consent is an ethical and legal requirement for research involving human participants. It is the process where a participant is informed about all aspects of the research, which are important for the participant to make a decision and after studying all aspects of these aspects of

the research, the participant voluntarily confirms his or her willingness to participate in it. So Informed Consent means that subjects are well informed about the study, the potential risks and benefits of their participation and that it is research, not therapy.

Obtaining informed consent for a research study requires open and honest communication between the researcher and the study participant. Much attention should be given to the consent document readability and its comprehension, as well as the conversation, which should be based upon the key elements of the consent document including: the research objectives, procedures, duration, risks, benefits, alternative options, confidentiality of records, contact information for any participant questions, compensation if applicable, additional costs and compensation for research injury if applicable. It is essential that participants understand that participating in a research study is completely voluntary; they can withdraw from the study at any time or choose not to participate.

Harm to Respondents

Ethically speaking, researchers have some general obligations to the people (respondents) who provide data for their research studies. These include:

- Participants should not be harmed.

78

- Participants should not be deceived.
- Participation should be willing and informed.
- Data should be held in confidence.

This is the first obligation of researchers to participants, not to harm them in any way. Although physical harm is very rare in survey research, emotional or psychological harm is common. The obligation not to harm participants, means that they shouldn't be embarrassed, ridiculed, belittled, or generally subjected to mental distress.

There have been reports and literatures about negative emotional reactions in some survey research respondents, but also some potential benefits for respondents. Examples of some of these are: informing respondents of sensitive topics; respondents could refuse to answer; respondents could call a number to reach a counselor. So, there is actually the probability of harm (physical, psychological, social, legal, or economic) occurring as a result of participation in a research study.

Reciprocity in Research Relationships

Codes of ethics state: "Research should involve an essentially collaborative relationship between researcher and the research participants." "Researchers should recognize their debt to the societies in which they work and their obligation to reciprocate with people studied in appropriate ways." Reciprocity concerns balanced patterns of giving and taking between people. Good research ethics practice requires that researchers consider what they take from research participants as well as what they give to them.

The researcher–participant relationship has the potential to be reciprocal: a relationship in which each contributes something the other needs or desires. Participants devote their time, effort, experiences, and wisdom to inform and shape the researcher's study. The researcher's scope,

depth, and nature of inquiry introduce vulnerability to participants' lives. In turn, researchers are susceptible to variable involvement and apathy from participants. While neither the relational aspect of research nor its potential for reciprocity is new, we are concerned that the concept is overshadowed in the current, positivistic culture of evidence in research.

Reflexivity and Ethics in Research
Reflexivity is a process whereby researchers place themselves and their practices under scrutiny, acknowledging the ethical dilemmas that permeate the research process and impinge on the creation of knowledge. This means that ethics is one aspect of reflexivity.

Now, research is primarily an enterprise of knowledge construction. The researcher, with his or her participants, is engaged in producing knowledge. This is an active process that requires scrutiny, *reflection*, and interrogation of the data, the researcher, the participants, and the context that they inhabit. So research can be said to be a reflexive process. Reflexivity in research or reflexive research means that the researcher should constantly take stock of their actions and their role in the research process and subject these to the same critical scrutiny and interpretation as the rest of their "data."

79

From the foregoing, a useful connection can be made between reflexivity and ethics. In this instance, we note that reflexivity is not necessarily focused only on the production of knowledge
58 search (what might be called the epistemological aspect of research practice) but also on the research process as a whole. The goal of being reflexive in this sense has to do with ethically improving the quality and validity of the research and recognizing the limitations of the knowledge that is produced, thus leading to more rigorous research.

4.0 Conclusion
In this unit you have considered the general principles on ethical issues in ICT research. You learnt the ethical principles guiding ICT research as well as the ethical issues involved in planning, conducting and reporting ICT research.

5.0 Summary
In this unit, all researchers are faced with time-driven competitive pressures to research and publish, to achieve tenure, and some to deliver on grant funding proposals. And invariably, the rapid pace of transformations in ICT has been reflected in the ethical issues involved in ICT research.

6.0 Tutor-Marked Assignment
1. Explain the general principles on ethical issues in ICT research
2. Discuss the ethical principles guiding ICT research
3. Discuss the ethical issues involved in planning, conducting and reporting ICT research.

7.0 References/Further Readings
1. Rogerson S. (2011). Ethics and ICT. Researchgate @ <https://www.researchgate.net/publication/236963923_Ethics_and_ICT>.

2. Sudman S. (1998) ,"Survey Research and Ethics", in NA - Advances in Consumer Research Vol. 25, eds. J. Alba & J. W. Hutchinson, Provo, UT : Association for Consumer Research, pp 69-71.
3. Trainor, A., & Bouchard, K. A. (2013). Exploring and developing reciprocity in research design. International Journal of Qualitative Studies in Education, 26(8), 986-1003. DOI: 10.1080/09518398.2012.724467

UNIT 2 APPLICATION OF CONCEPTS AND CRITICAL ENGAGEMENT WITH ISSUES RELATING TO PERSONAL RESEARCH NEEDS

CONTENTS

1.0 INTRODUCTION

In this unit you will consider what critical engagement is. You will also learn the issues relating to personal research needs and how both concepts and critical engagement can be applied to these issues.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what critical engagement is
- itemize the issues relating to personal research needs

- discuss briefly how concepts and critical engagement can be applied to the issues relating to personal research needs

3.0 MAIN CONTENT

3.1 What is Critical Engagement?

Critical engagement (or thinking) is clear, reasonable, reflective thinking focused on deciding what to believe or do. It means asking probing questions like, "How do we know?" or "Is this true in every case or just in this instance?" It involves being skeptical and challenging assumptions, rather than simply memorizing facts or blindly accepting what you hear or read. Imagine, for example, that you're reading an ICT textbook. You wonder who wrote it and why, because you detect certain biases in the writing. You find that the author has a limited scope of research focused only on a particular area within the discipline. In this case, your critical thinking reveals that there are "other sides to the subject."

Researchers who engage in critical thinking are usually curious and reflective people. They engage the ideas of other critical writers and so communicate the relevance of their argument to a field of interested scholars by showing where their ideas fit with those already established in the field. They also like to explore and probe new areas and seek knowledge, clarification, and new solutions. They ask pertinent questions, evaluate statements and arguments, and they distinguish between facts and opinion. They are also willing to examine their own beliefs, possessi 81 manner of humility that allows them to admit lack of knowledge or understanding when needed. They can add to the power and persuasion of their own argument by collaborating with ideas already in the field, or by posing a challenge to another critic. They are open to changing their mind. Perhaps most of all, they actively enjoy learning, and seeking new knowledge as a lifelong pursuit.

3.1.1 Steps of Critical Engagement with Issues Relating to Person Research Needs

Some of the ways to engage critically with issues relating to person research needs are the following:

Offer an Overview of the Critic's Argument

When you engage critically, you can assume that your reader has a rudimentary understanding of the critical conversation that you are entering. That means that you need to start out with an introduction to and characterization of the critic's argument before you can build off or diverge from it. This overview also sets your audience up to see exactly how you differ from another author, even if by and large you agree.

Focus on a Specific Claim

Engagement, like close reading, relies on working with a very specific portion of a text. Although there may be an overall argument for the critical essay, that overall argument is built and substantiated by smaller sub-arguments. It's important to have a general sense of the essay's overall argument and to be able to describe it in your characterization, but you actually build off or diverge from individual points in the essay. These individual points need to be specific enough

so that you can locate them in the text and paraphrase them. They should be sub-claims that could be readily detected by any reader of the argument. As with close reading, this means you stick dutifully to the explicit ideas of the text.

Craft your Response by Extending or Challenging the Argument

Your response will necessarily extend or challenge the argument you engage with. There are three options to this according to Graff and Birkenstein; you can:

a. disagree—and explain why;
b. agree—but with a difference; or
c. agree and disagree simultaneously with ample explanation.

This model ensures it will be clear that you're not simply agreeing or disagreeing for the sake of it. By justifying why you agree or disagree, you make explicit how you're extending the conversation about atopic.

The production of new knowledge begins with acknowledging what has been said before and recognizing that another author—you—has a different but meaningful take on the same topic. Whatever your response, you are effectively making a sub-claim for your overall argument; as with any claim, this one needs to be supported by specific, closely read evidence from the text.

82

Present your own Critical Perspective: State the Significance

Engagement results in your production of an original critical perspective that can then be used as a vantage point for close readings of literary texts. It's important to articulate this critical perspective by stating the significance of your engagement with the critic—this is where you offer your reader some payoff for having trotted him/her through another critic's argument, and your response to it. Where has this gotten us? What new insight emerges through your extension of or challenge to that argument? Be explicit about your contribution, and use this to build a transition to the next part of your argument.

3.2 Issues Relating to Personal Research Needs

Every researcher has his/her personal research needs. These needs depends varies among individuals and their chosen specialty in the field of ICT. The specific needs of ICT researchers impact on all ICT field, regardless of their level of engagement in ICT research. The key issue relating to personal research needs consists in the researcher developing his personal and professional capabilities.

The process of the researcher developing his personal and professional capabilities can start by undertaking a higher degree in his field. By undertaking an MSc, PhD, or a professional masters or doctorate, the candidate is on his/her way to producing excellent research. However, this is also about developing his personal and professional capabilities. So undertaking a higher degree is a very important way of meeting a person's research need. Whether this is as the start of a career in research, needs a self-development within an existing career, or the broadening of

capabilities and improvement of employability, this type of training in research will give the individual the skills he/she needs.

Some universities and institutions has developed a "needs-based" approach in the higher degree training where individual's research needs are provided for which provides flexibility in the training that you will undertake. All these are meant to each person's research needs. A number of these research needs has been identified as follows:

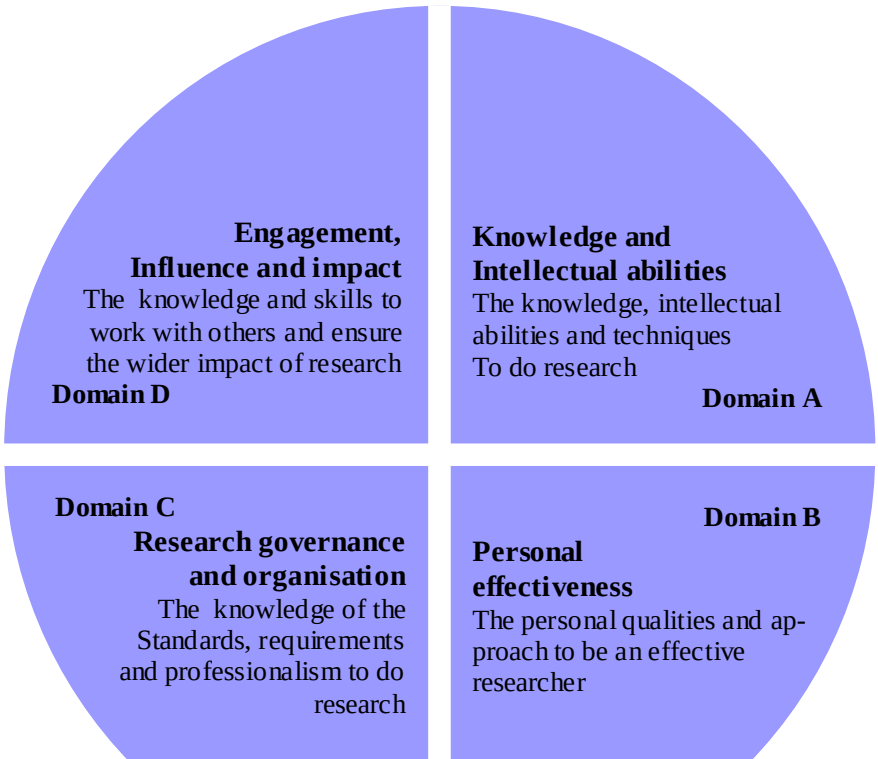
- To frame a research question and propose an appropriate methodology to answer this
- To apply relevant research methodologies and techniques
- To analyze, interpret, and communicate research findings

3.2.1 Development of Personal Research Needs

There are four domains available for any researcher to effectively develop his research needs. The University of Leicester in the United Kingdom (UK) has developed their postgraduate training around these four domains, which they called *Researcher Development Framework.* The Research Development Framework was launched in 2010 and is a UK-wide statement of the knowledge, skills, and behaviour that characterize an effective and highly skilled researcher and which are looked for by graduate employers.

The four "domains" of the development of personal research needs, shown in Figure 5.1, are the following:

- Knowledge and Intellectual Abilities
- Personal Effectiveness
- Research Governance and Organisation
- Engagement, Influence, and Impact



3.3 Application of Concepts and Critical Engagement with Issues Relating to Personal Research Needs

Engagement is being widely recognized as critical to the research process. Whether formally or informally, critical engagement has been seen to arise during most discussions about ICT research. Critical engagement is arguably one of the central requirements and desired outcomes in the universities globally. Every researcher is expected to be aware of the importance of argumentation in research writing or have an understanding of what is meant by the concept of argument, evaluation and analysis.

84

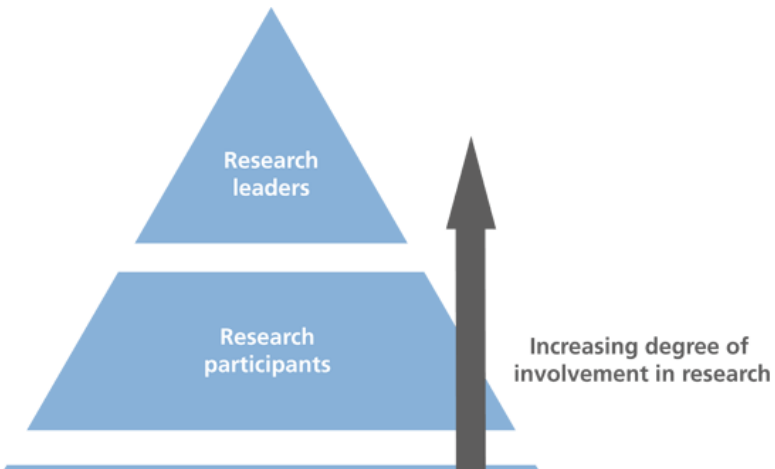
3.3.1 Levels of Critical Engagement of ICT Researchers

It is clear that critical engagement in research improve the outcome of the researcher's work. Research evidence is the fundamental way in which routine professional practice is improved. Critical engagement or thinking by the researcher is an essential precursor for the incorporation of research evidence into practice. Training in these skills also cultivates an interest in undertaking the much needed ICT research.

There are varying levels of engagement in critical thinking and research in the ICT research and practice. About three levels of engagement have been delineated as follows (Figure 5.2):

- Research leaders
- Research participants
- Research users

Each is expected to be actively involved at the highest order within each level of involvement.



Research leaders– These are those who conceptualize, design, find funding for, conduct and publish research. The bulk of the research work is on them
Research participants– These are those who participate in the ICT research. Some research participants are intellectually engaged in the research, understand and feel aligned to its purpose, and could describe the project to a third party, and are interested in the results. Some other participants may just be respondents to surveys or other research tools.
Research users - All ICT professionals are research users, using research evidence (the base of the triangle) in their practice. This research evidence is accessed in a range of forms from a wide number of sources such as journals, ICT newspapers, formal educational activities discussions with colleagues, and can lead to changes in practice.

4.0 Conclusion
In this unit you have studied what critical engagement is. You also learnt the issues relating to personal research needs and how both concepts and critical engagement can be applied to these issues.

5.0 Summary
In this unit, Critical engagement (or thinking) is clear, reasonable, reflective thinking focused on deciding what to believe or do. Every researcher has his/her personal research needs. These needs depends varies among individuals and their chosen specialty in the field of ICT. There are four domains available for any researcher to effectively develop his research needs. And about three levels of engagement have been delineated.

6.0 Tutor-Marked Assignment
1. Explain briefly what critical engagement is
2. Itemize the issues relating to personal research needs
3. Discuss briefly how concepts and critical engagement can be applied to the issues relating to personal research needs

7.0 References/Further Readings

1. UW(2010). Critical Engagement, Department of English, University of Washington @ <https://english.washington.edu/sites/english/files/documents/ewp/ha2.pdf>
2. RACGP (2016). Critical thinking and research. @ <https://curriculum.racgp.org.au/statements/critical-thinking-and-research/>
3. UL (2018). Developing Your Personal and Professional Capabilities. University of Leicester, UK @ <https://www2.le.ac.uk/research-degrees/about/training>

UNIT 3 ASSESSMENT ITEMS RELATED TO PERSONAL RESEARCH TOPIC

CONTENTS

1.0 INTRODUCTION

In this unit you will consider what personal research topic is. You will also learn how to use assessment items to choose a personal research topic.

2.0 OBJECTIVES

After going through this unit, you should be able to:

- explain what personal research topic is
- enumerate how to use assessment items to choose a personal research topic

3.0 MAIN CONTENT

Assessment influences every level of the ICT research. Assessment provides feedback, ranks researchers, defines and protects academic and professional standards, and directs researchers' learning. Essentially, assessment must function to promote self-directed learning and develop high-order cognitive skill.

Assessment takes a wide range of forms, and each has its unique merits and limitations. Considerable efforts have been made in designing examination questions for assessments of researchers from the stage of selection of their research topic to the final submission. It is commonly accepted that a poorly devised assessment may push researchers to merely copy relevant information in other sources.

3.1 Personal Research Topic

A research topic is a subject or issue that a researcher is interested in when conducting research. It can be both a research question and a hypothesis. A well-defined research topic is the starting point of every successful research project. Choosing a topic is an ongoing process by which researchers explore, define, and refine their ideas.

Being able to choose a suitable research topic is an important skill to have for any researcher. Not only is it the difference between writing a good research paper and falling flat on the face, it's imperative if the process is going to run smoothly. The importance of writing a good research can lead researchers to feel an enormous and looming weight hanging over their heads as time passes, however, if the researcher knows a few crucial steps choosing the ı 87 topic can be quick, easy and even fun.

You will spend many hours working on your research paper, so you are best off choosing a subject and a research topic you find interesting. After making your choice, you should assess and evaluate whether it is realistic for you to finish your paper in time. Don't forget that you will need more time if you are not already familiar with the topic you have chosen. Your research topic can be based either on an observed phenomenon or on facts.

3.2 Assessment Items Related to Personal Research Topic

Most of the important assessment a researcher requires to choose a good research topic is by self. Although for an academic research, the researcher will have need for a supervisor's assessment of the chosen research topic. So whether the research is academic, business or corporate, the same set of assessment will be relevant for the research to come out with a researchable topic.

As part of the assessment, a researcher will find out that even when he has chosen a topic, he may need to revise the topic. This may be important because there after working on the paper for a while, he/she will discover aspects he/she did not initially think of. Revision of topic must be done freely and most flexibly, so the researcher should therefore be open to revising his/her research topic.

3.2.1 Selecting a Research Topic

The ability to develop a good research topic is an important skill. In some cases, especially in the academia, a supervisor may assign a specific topic to the researcher, but most often supervisors require the researcher to select his/her own topic of interest. When deciding on a topic, there are a few things the researcher will need to do. These are the main assessment (or checklist) required. They include:

- brainstorm for ideas
- choose a topic that will enable you to read and understand the literature
- ensure that the topic is manageable and that material is available
- make a list of key words
- be flexible
- define your topic as a focused research question
- research and read more about your topic
- formulate a thesis statement

The main steps to follow in the process of selecting a research topic are the following:

Step 1: Brainstorm for ideas

Choose a topic that interests you. Use the following questions to help generate topic ideas.

- Do you have a strong opinion on a current technological need
- Did you read or see a news story recently that has piqued your interest, made you angry or anxious?

- Do you have a personal issue, problem or interest that you would like to know more about?
- Is there an aspect of a subject that you are interested in learning more about?
- Look at some of topically oriented Web sites and research sites for ideas.
- Are you interested in application of ICT to health or medicine or any other field?

Be aware of overused ideas when deciding a topic, unless you feel you have a unique approach to the topic. Ask your colleagues or supervisor for ideas if you feel you are stuck or need additional guidance.

Step 2: Read General Background Information

Read a general encyclopedia article on the top two or three topics you are considering. Reading a broad summary enables you to get an overview of the topic and see how your idea relates to broader, narrower, and related issues. It also provides a great source for finding words commonly used to describe the topic. These keywords may be very useful to your later research. If you can't find an article on your topic, try using broader terms and ask for help from a librarian.

Use periodical indexes to scan current magazine, journal or newspaper articles on your topic. Ask a librarian if they can help you to browse articles on your topics of interest. Browse the net.

Use Web search engines. Google and Bing are currently considered to be two of the best search engines to find web sites on the topic.

Step 3: Focus on Your Topic

Keep it manageable. A topic will be very difficult to research if it is too broad or narrow. One way to narrow a broad topic such as "the computer applications" is to limit your topic. Some

common ways to limit a topic are: by geographical area, by culture, by time frame, by discipline, by population group. Remember that a topic may be too difficult to research if it is too: locally confined, recent, broadly interdisciplinary, popular etc.
If you have any difficulties or questions with focusing your topic, discuss the topic with your supervisor, colleague or with a librarian

Step 4: Make a List of Useful Keywords
Keep track of the words that are used to describe your topic. Look for words that best describe your topic. Look for them when reading encyclopedia articles and background and general information. Find broader and narrower terms, synonyms, key concepts for key words to widen your search capabilities. Make note of these words and use them later when searching databases and catalogs.

Step 5: Be Flexible
It is common to modify your topic during the research process. You can never be sure of what you may find. You may find too much and need to narrow your focus, or too little and need to broaden your focus. This is a normal part of the research process. When researching, you may not wish to change your topic, but you may decide that some other aspect of the topic is more interesting or manageable.

Keep in mind the assigned length of the research paper, project, bibliography or other research assignment. Be aware of the depth of coverage needed and the due date. These important factors may help you decide how much and when you will modify your topic. Your supervisor will probably provide specific requirements.

Step 6: Define Your Topic as a Focused Research Question
You will often begin with a word, develop a more focused interest in an aspect of something relating to that word, then begin to have questions about the topic. For example:

- Ideas = Artificial intelligence or Medical practice
- Research Question = How can artificial intelligence be used to advance medical practice?
- Focused Research Question = What specific area of artificial intelligence and design principles will be required for this?

Step 7: Research and Read More About Your Topic
Use the key words you have gathered to research in the catalog, article databases, and Internet search engines. Find more information to help you answer your research question. You will need to do some research and reading before you select your final topic. Can you find enough information to answer your research question? Remember, selecting a topic is an important and complex part of the research process.

Step 8: Formulate a Thesis Statement

Write your topic as a thesis statement. This may be the answer to your research question and/or a way to clearly state the purpose of your research. Your thesis statement will usually be one or two sentences that states precisely what is to be answered, proven, or what you will inform your audience about your topic. The development of a thesis assumes there is sufficient evidence to support the thesis statement.

4.0 Conclusion

In this unit you have studied what personal research topic is all about. You also learnt how to use assessment items to choose a personal research topic.

5.0 Summary

In this unit, assessment influences every level of the ICT research. It provides feedback, ranks researchers, defines and protects academic and professional standards, and directs researchers' learning. A research topic is a subject or issue that a researcher is interested in when conducting research. It can be both a research question and a hypothesis. A well-defined research topic is the starting point of every successful research project. Most of the important assessment a researcher requires to choose a good research topic is by self.

6.0 Tutor-Marked Assignment

1. Explain what personal research topic is
2. Enumerate briefly how to use assessment items to choose a personal research topic

7.0 References/Further Readings

1. UMFLINT (2018). How to Select a Research Topic. Univercity of Michigan-Flint, USA. @ <https://www.umflint.edu/library/how-select-research-topic>

2. Vyncke M. (2012). The concept and practice of critical thinking in academic writing: an investigation of international students' perceptions and writing experiences, King's College, London, UK @ <https://englishagenda.britishcouncil.org/sites/default/files/filefield_paths/m_vyncke_0_1.pdf>