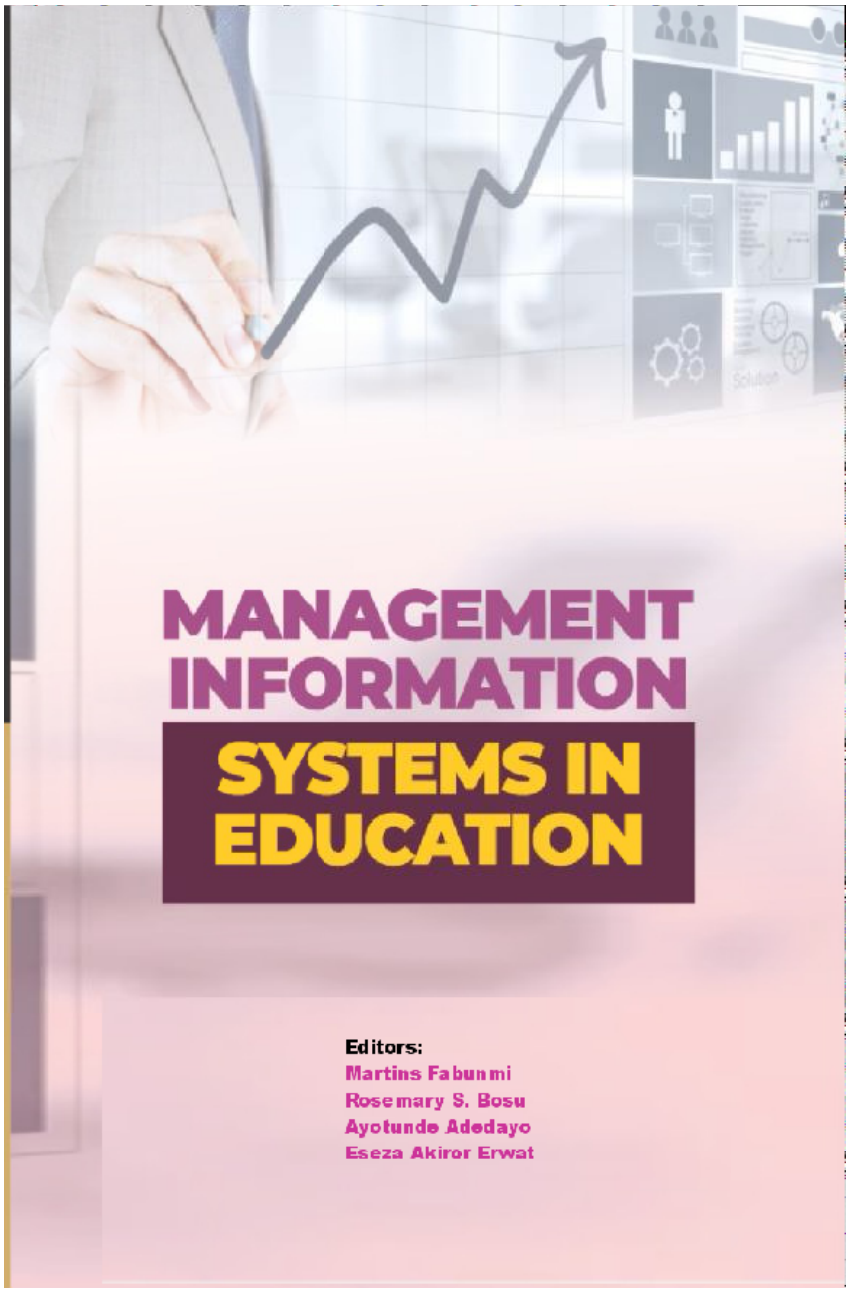

MANAGEMENT INFORMATION SYSTEMS IN EDUCATION

Editors:
Martins Fabunmi
Rosemary S. Bosu
Ayotunde Adedayo
Eseza Akiror Erwat

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Editors
Martins Fabunmi
Rosemary S. Bosu
Ayotunde Adebayo
Eseza Akiror Erwat

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Review Process

Fifteen articles were submitted for publication as chapters in this book. The articles were subjected to a thorough process of double-blind peer review. The professionals in EDUDIA's team of Reviewers were from universities in different countries. They were strictly guided by the EDUDIA's Review Criteria. They were also requested to look at the manuscripts with the view to assisting authors produce quality articles that best meet learners' needs.

Following the review process, the editorial committee considered the reviewers' comments; and two articles were unsuitable for publication. The authors of the suitably qualified articles were given the reviewers' reports and asked to use the suggestions to strengthen their papers. After receiving the corrected manuscripts, the editorial committee finally accepted 13 of the 15 qualified articles for inclusion in this Book: *Management Information Systems in Education*. That means that the acceptance rate was about 86.7%.

Preface

This book, titled Management Information Systems in Education, is derived from responses to a call for contribution of chapters from erudite scholars sometimes in January 2022. The following four accomplished scholars edited the book: Professors Martins Fabunmi and Rosemary S. Bosu of the Institute for Educational Planning and Administration (IEPA), University of Cape Coast, Ghana; Professor Ayotunde Adebayo of the University of Lagos, Nigeria; and Professor Eseza Akiror Erwat, Lead City University, Ibadan, Nigeria. Virtually all the authors are very senior academics with rich experiences in writing scholarly articles. Some of them are even professors, while others are budding erudite lecturers.

This book comprises thirteen chapters with the following titles: The Scope of Management Information System; Brief History of the Development of Information and Communication Technology (ICT); information Systems in Organizations; The Role of Information Systems in Education; Communication and Information Systems in Education; Theories and Models of Information and Communication Technology Adoption; Information Systems in Education; Data Processing; System Analysis and MIS in Education; Information Systems in Business Organizations; Resources Needed in an Information System; Information System Development and Acquisition; and Information Security and Controls.

EDUDIA addresses the shortage of e-books of African backgrounds. The association has started with management in education, with this book dealing with the Management Information Systems aspect of the discipline. The book contains articles on exigent issues in Management Information Systems in Education. EDUDIA continues to solicit scholarly articles from authors in

different disciplines from all over the world through conferencing. I, therefore, implore all teacher educators to be part of this mass movement and have their articles published in globally visible publishing outlets.

In view of these developments, I recommend this book as a must-read for everybody, irrespective of discipline. The book deals with Management Information Systems in Education in a way that makes it a useful learning material for learners, an instructional and dependable guide for teacher educators, administrators, and everyone, no matter the professional calling. It is useful for family heads, religious leaders, community leaders, heads of organisations, and members of different groups. Finally, I am grateful to the co-editors for making the publication of this book, *Management Information Systems in Education*, possible.

Professor Martins Fabunmi (FGEN),
Institute for Educational Planning and Administration (IEPA),
University of Cape Coast, Ghana.

TABLE OF CONTENTS

Chapter 1

THE SCOPE OF MANAGEMENT INFORMATION SYSTEM

Memory Queensoap, *PhD*
Dogitimiye Memory, *PhD*

INTRODUCTION

Education is one of the most vital instruments in changing an individual as well as the society. It is a powerful tool of socio-political cum economic change, without which neither an individual nor a society can attain professional growth. Education has been seen as the instrument per excellence for effecting national development (Federal Republic of Nigeria (FRN)., 2004). Education fosters the worth and development of the individual and for general development of the society. Educational management, planning and administration is an aspect of education that provides education and required skills to co-ordinate human and material resources towards the attainment of pre-determined objectives. It focuses on the enhancement of teaching and learning as well as involving the service, activity or tool through which the fundamental objectives of the educational process may be more fully and efficiently realized.

The emergence of Information and Communication Technology (ICT) has changed the implementation of educational management, making it more efficient and effective than ever before. ICT, according to (Federal Republic of Nigeria (FRN), 2012), includes any equipment or interconnect system of equipment that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission or reception of data or information resources. This equipment includes

but not limited to both hardware and software such as computers, printers, internet, website, scanner, facsimile, telephone, mobile phone, photocopiers, video conferencing, teleconferencing, service programs, web browsers, operating systems and simulation, etc.
These ICT facilities have great impact on the educational system through what we can refer to as Management information system (MIS). MIS is an integrated system for providing information to support the planning, organization, control function that covers the unction's of middle management from management special reports (Navaz, 2013). Therefore, this chapter deals with the scope of management information systems (MIS).

BASIC CONCEPTS

Management Information System (MIS) consists of three key words namely management, information and system which are conceptualized as follows:

Management: Management, simply put, is an art of getting things done by others. However, for the purpose of Management Information System, management can be described as an art that comprises the process and activity that a manager does in the operation of their organization, that is, to plan, organize, direct and control operations.

Information: Information simply means processed data or data which can be converted into meaningful and useful form for a specific user. Information is data that is processed and is presented in a form which assists decision- making. Data are raw or crude or unprocessed materials which are obtained for meaningful use. Data usually take the form of historical records. In contrast to information, raw data are ordinarily meaningless, may not be organized and may not add anything to our knowledge. For data to be meaningful it must be processed as: Data→ Processing →Information.

System: A System is a group of interrelated components working together toward a common goal by accepting inputs and producing outputs in an organized transformation process.
The concepts of a system are Technology, Application, Development and Management.

a. Technology: Computer networks are systems of information processing components that are a variety of hardware, software and telecommunication technology.
b. Application: That electronic business and commerce application involves interconnected business information system
c. Development: That developing way to use Information Technology (IT) in business includes designing the basic component of information system.
d. Management: Managing IT emphasizes the quality, strategic business value and security of an organization in information system

Components of a System

There are three basic components of a system, they are input, processing and output.

a. Input: Input involves capturing and assembling elements that enter to the system to be processed. Some of the inputs are raw materials, energy, data etc.
b. Processing: It involves transformation process that converts input to output.
c. Output: It involves transforming element that has been produced by a transformation process to their ultimate destination.

Types of System

a. **Dynamic System:** When the interrelated component of the system interacts with each other, and this controlled by management then it is known as Dynamic System.
b. **Cyber-native System:** Dynamic System implementing the concept of feedback and control is known as Cyber native System.
c. **Open System:** A system got interacts with other system in its environment by exchanging input and output with its environment
d. **Adoptive System:** A System having the ability to change itself and its environment to survive is called an Adoptive System.

Meaning of Information System and its Scope

The concept of information system can mean several things to several scholars. It is a coordinated group of components that integrate managerial functions to support various activities and goals of organizations. Information system can aid with communication, operation and decision-making process of the organization. According to Alcami and Caranana (2012), the information system is a formal set of processes that, working from a collection of data structured depending to the organizational needs, gathers, processes and distributes the information necessary for the organization's operations and for its corresponding management and control activities, thereby supporting, at least in part, the decision-making processes necessary for the company to perform its business functions in line with its strategy. A critical look at this definition informs that informal information system is exclusive. This does not water down the relevance of informal information system. Rather, it indicates the limitations of informal information system which provides information by chance and not the result of a designed process. Hence, the formal information systems are buttressed emphatically.

Purkar et al. (2023) presented information system as an integrated framework designed for the collection, storage, processing, and

dissemination of data and information, encompassing physical elements like cards and digital products. This implies that organization relies on these systems to orchestrate their operations and competitions. As information systems continually evolves, largely propelled by the advancement of ICT, it becomes a pivotal force driving change (Purkar et al., 2023). The breadth of information system applications spans across various domains, with a notable presence in the business sector. In fact, the scope of information system covers the collection, storage, processing, and delivering of data, information, knowledge and digital products.

Moreover, information system has three major dimensions of operations or functionality which include the organization, the management and the technology. Information system is an integral part of organization which fundamental elements such as the people, the structure, business process, politics and culture are heavily relied on the information system.

Types of Information Systems

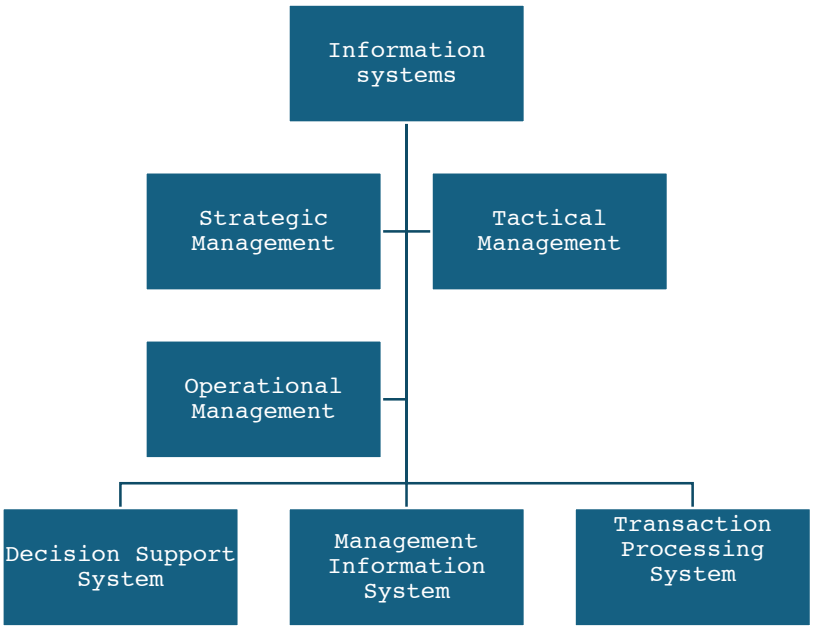

Figure 1: Types of Information Systems (adapted from Purkar et al., 2023)

Strategic management: This relates the requirement needed by managers at the strategic level of management for the formulation of organizational strategies.

Tactical management: This type of information system used in short term planning as well as useful at the management control level.

Operational management: It applies to short periods which may vary from an hour to a few days.

Decision Support System: DSS as an information system application helps in making decision. It tends to be designed basically to serve management control level and strategic planning level management.

Management information system: MIS as a category of information system is used to process data and converts it into information. It has been observed that MIS made use of transactional processing system for data inputs.

***Transaction processing system*:** This represents the automation of the basic routine process used to support business operations. It does not provide any information to the end users for their decision making.

COMPONENT OF INFORMATION SYSTEMS

There are different components of information systems. We can identify the following as major components:

Hardware: This includes physical devices and materials used in information processing such as computer system (laptop, midrange computer, etc.) and computer peripherals (keyboard or electronic mouse, printer, etc.).

Human resources (HR): HR is a functional information system that supports the functions of human resource management of an organization. These functions include manpower planning, staffing, training and development, performance evaluation or appraisal, etc. We have two types of human resources namely information system specialist and end users. The information specialist includes system analysts, programmers and operators while the end users are the people who use the information system.

Telecommunications: These are network resources such as internet, intranets and extranets. This emphasizes that communication technologies and networks are primary resources of all information systems. These include communication media, network infrastructure

Software: It consists of all set of information processing instructions such as system software and application software.

Data base: These are organized, stored and accessed by variety of data resources management technologies. They can take the form of processed and organized data or knowledge base data which presents as facts, rules and cases.

Procedures: These are referred to as the policies and methods that are enshrined that should be followed when using operating and maintaining an information system. For example, to establish when to run the organization's payroll program, to determine how many times it should run, who will be authorized to do so and who has access to the reports it produces (Alcami & Caranana, 2012).

Meaning of Management Information System (MIS) and its Scope

MIS is acronym for management information systems, and pronounced as separate letters. It refers broadly to a computer-based system that provides managers with the tools for organizing, evaluating and efficiently running their departments. MIS is an analytical tool that enables the integration of data from different business applications, Internet, different modules and business functions. It converts data from internal and external sources into information. This information is communicated in an appropriate form to managers at different levels in a business to enable them to make effective decisions.

A management information system (MIS) is a process that provides information needed to manage organizations effectively. It is regarded to be a subset of the overall internal procedures in a business, which cover the application of people, documents, technologies, and procedures used by management personnel to solve business problems such as costing a product, service or a business-wide strategy (Mbam, 2010). Management information systems are distinct from regular information systems in that they are used to analyze other information systems applied in operational activities in the organization.

Similarly, (Navaz, 2013) opined that Management Information Systems (MIS) are information systems, typically computer-based, that are used within an organization. WorldNet as cited in Navaz (2013, p.7) describes an information system as "a system consisting of the network of all communication channels used within an organization".

It involves all channels with which the organization utilizes in making communication effective and efficient from top to bottom level of workers and vice versa. In another vein management information systems (MIS) are regarded as a crucial instrument in the business

landscape, serving as an antiseptic and antidote to address and facilitate informed decision-making inside organizations. Companies and businesses are motivated to adopt a proactive strategy in data analysis, ensuring the provision of trustworthy, comprehensive, easily available, and comprehensible data within an appropriate amount of time to system users (Justice & Olorunda, 2023).

Meanwhile, Purkar et al. (2023) established that a Management Information System (MIS) is a crucial element in modern organizations. It encompasses a set of flow-processing procedures that are computer-based and integrated with other processes to deliver timely and effective information. This information is instrumental in supporting decision-making and other vital management functions. The significance of MIS becomes even more apparent as the volume of business data and information continues to exponentially grow. We can go on and on to define MIS because there are several definitions put forward as a system that encompasses networking of information flow however all definitions points to a single fact that MIS is a system that supports the decision-making function in the organization.

The scope of MIS is encompassing as its nature suggests. (Team Leverage Education, 2023) If Information Systems is a speedy growing system that had generated a promising prospectus and career development in this present world. ICT turning the world as a global village, everything is being digitalized which has tremendously influenced the demand for MIS professionals more than ever. This increasing demand has as well influenced the scope of MIS to involve performing several tasks simultaneously such as:

- Processing data
- Initiating transactions
- Responding to inquiries
- Producing reports and its summaries

- Manage the data created within the structure of a particular business

MIS acts in an organization just like a nervous system in a body by providing with the relevant information for ease in the process of decision making**.** The overall goal of Management Information System is to help in decision making process, which can be applied in areas like planning, directing, forecasting, coordinating, controlling. The scope of MIS can be likened the human nervous system and how the nervous system influences the human body. MIS influences the entire workings of any organization. It is the working memory of the organization.

Roles of Management Information Systems (MIS) in Organizations

The significance of MIS in an organization cannot be overemphasized and thus the role of MIS has been likened to the way the heart functions in the human body. Mbam (2010) presented that the blood of the human being is the information while MIS is the heart. It is physiologically known that the heart plays the role of supplying pure blood to all the parts of the body including the brain. This implies that the MIS supplies information to all elements of the organization. Mbam (2010) identified the followings as roles of MIS in any organization.

- MIS ensures the collection of appropriate data from the required sources.
- It helps to satify the various needs of the organization through established information systems such as DSS, Modelling systems, transactional processes, etc.
- It assists in the clerical personnel in transactional processing and answers their queries on the data pertaining to the transaction.
- MIS helps the middle management in short term planning, target setting and controlling the business functions.

- It also help in the information generation, communication, problem identification and help in decision making process.

Similarly (Justice & Olorunda, 2023) posited that there are several ways in which MIS activily assist in the enhancement of business processes. These ways include data collection and storage, streamlined communication,automation of routine tasks, decision support, enhanced planning and forcasting, process standardization, improved reporting, supply chain management, customer relationship management, employee performance monitoring, compliance and risk management, continuous improvement, data accuracy and consistency, cost reduction, and efficient decision making.

Levels of Management in Organizations and Information Requirements

There are three levels of management that could be are identified in any organizations. They include top management cadre (strategic level), middle management cadre (tactical level) and operational group carder (operational level) (Mbam, 2010; Terry, 2014).

Top Strategic/Management Level

Management levels are categorized to perform specific functions to achieve the set goal and objectives for the organization. Top strategic level deals with establishing the overall objectives of the organization and formulating appropriate policies to ensure the attainment of the organizational goals. The specific role performed at this level include long term planning, capital investment, organizational restructuring, middle management appointments, and acquisitions and mergers. According to Terry (2014), formal MIS have a limited role especially in the processing of information. However, there is a need for an MIS to obtain information about the environment by a scanning and information gathering process in order to identify potential threats

and opportunities. Terry (2014) identifed six areas of information requirements at the top strategic level of management. These are;

Largely external: This deals with external environment. Information is higly required concerning the external environment of the orgainzation. For example competitor's performance and actions, market changes, political factors, etc.

Information concerned with the future: It is at the top strategic level of management that formulate policies and make strategic planning which consist of both long term, middle term and short term. This information will enable the management level to identify trending issues, make forecast and assessment to secure the future of the organization.

Qualitative as well as quantitative: Strategic planning and decision making requires quantiative information which are measurable and numerical however qualitative options such as judgement, insight and observations are as well needed especially for political and social factors.

Largely informal: However limited informal information may be present they should not to be disregarded. Top strategic management needs largely informal information to curb certain unwarranted environmental disturbances.

Boundary free: There is no limitation of information needed at this top strategic management level. Information must be broad ranging and unrestricted to have a holistic view of the organization.

Multi-Dimensional information requirement: Top strategic management is saddled with strategic functions, policy making and decision making hence information requirement is multi-dimension. It cannot be steriotyped to one direction. It must be a two way or

multiple direction communication channel to obtain information for the atatinment of the organizational goal and objectives.

Middle Management Level

This level of management is also operationally known as tactical level of management. The sole responsibility of this level of management is to implement top management policy. They are responsible to the top strategic management level. This level of management does set objectives but they are more limited in scope and are subordinate to the objectives set by top management level (Mbam, 2010). Some of the functions of the middle management are purchasing, product planning, sales promotion, discount and credit policy, staff appointment and implementation of marketing and advertising policies of the organization. Information requirement borders on the function this level performs. It requires control systems with information feedback which are essential to carry out the monitoring role. Information, summaries, reports and alternatives are laterally flow from tactical level to top strategic management level hence needs MIS control and monitoring reporting, exception reporting, decision support, and modelling information source.

Operational Level of Management

Operation group carder of MIS deals with the day-to-day administration and process of supervision of the organization. This level manger gives direction associated with normal activities of the organization. The functions of the operational level are production, dispatching, sale, accounting, etc. the managers at this level may be designated with titles such as heads, supervisors, dean, etc. This level is often characterized as computer based (Terry, 2014). Therefore, this level requires control information and internal information which will enable them perform programmed decisions and transaction processing.

Communication and MIS

Communication is the live wire of any human relationship and the operating language of any organization. Everything in the organization revolves around communication and the kind of communication that goes on in an organization determines to a large extent how management levels relate with one another.

Communication is the phenomenon that describes the ability, means and process of passing information to another person (s) understandably (Nigerian Baptist Convention, 2024). It is the process by which individuals share information, ideas and attitudes as sender and receivers. It involves transmitting, receiving, analyzing and appreciating knowledge, ideas and experience among people. It is sharing, revealing and acting on or reacting to available information (Nigerian Baptist Convention, 2024).

To this end, communication serves as a center piece in MIS. Terry (2014) reported that the processing of data into information and communicating the resulting information to the end user are the very essence of an MIS. This portends that communication and MIS have a relationship that is symbiotic. MIS create the platform for effective communication among the levels of management while communication serves as the means by which information is being communicated. Terry (2014) argued that the link in the communication chain is clearly of critical importance to both the information system designer and user and again emphasizes the pervasive nature of human and behavioral factors in MIS. In a nutshell, communication can create value in MIS.

Basically, to achieve organizational goal and objectives, groups of management levels are required to communicate effectively. It is obvious that this group of management levels has been able to pass all necessary information in the form of communication within the different groups. It is equally important that information flows

according to set procedures. Communication can deter or speed MIS in an organization depending on how the procedures are observed. That is, if information from the top management level gets to the operational level before the middle management level such communication is bad and is capable of deterring the achievement of the organization. Therefore, information is to be communicated from top management level to operational level through the middle management level and vice versa (Mbam, 2010).

Benefits of MIS to Organizations

MIS is an important information system in an organization that is likened to the heart as it functions in the human body. There is no gainsaying that the heart is one of the most important parts of the body if not the most hence MIS seems to be very vital in the operations of an organization. To this, MIS is of immense benefit to an organization hence the following are some of the benefits of a reliable, accurate, current and easily accessible MIS to an organization.

- MIS helps to promote increased customer satisfaction
- Improve quantity and quality of information
- It helps to improve quality and quantity management decisions
- It creates an improved platform for appropriate response to organizational competitors.
- MIS helps to promote quality planning and formulation of workable policy for the organization
- MIS helps to fast tract and implement quality control system and supervision
- MIS organizations enjoy improve communication among levels of management
- MIS provides to organizations operational flexibility and efficiency
- MIS encourage decentralization of authority

Causes of Weakness of MIS in Organizations

It has been observed that MIS is beneficial to organizations however there some are observable weaknesses of MIS in an organization. A few of these weaknesses include;

- MIS may solve some critical problems but it is not a solution to all problems of an organization
- It cannot meet the special demands of each person because it does not provide exact information and that is the reason for the concept of decision support system was created in response to such needs.
- Poor design of MIS can give its relevance because it may not serve the management
- MIS is user dependent. If the users do not know how to leverage the information available from MIS, then MIS is of little use.
- MIS becomes unusable if the basic data is obsolete and outdated

From the foregoing therefore, what causes the weakness of MIS in organization can include its inability to solve all problems, designer dependability, user compliance, use of outdate and obsolete data and inability to provide exact information.

Challenges of MIS in Organizations

There are several challenges that confronts the effective operation of MIS in an organization. Some of them are highlighted below.

- Provision of budget estimate for MIS in an organization is very difficult because MIS is a network of resources
- It lacks flexibility to do self-update

- It is like garbage in garbage out. Quality of output is controlled by quality of inputs.
- MIS is highly sensitive and thereby requires constant monitoring
- Effectiveness of an organization is easily hampered due to frequent changes in top management

Nevertheless, some scholars divided the challenges into three major factors namely humanistic, organizational and environmental factors. The humanistic factors include;

- Information inadequacy of managers and users
- The lack of correct definitions of the needs and their analysis
- The lack of information of the managers and users about the collaboration method with designer team
- The lack of participation of the manager and users in the system design
- The lack of understanding of the managers of software and information system
- The lack of accuracy in data collected (Odisha State Open University, 2024)

Organizational factors

- The lack of good conditions for participation and collaboration of the managers, users and system designers
- Unfavorable implementation of the system
- Inadequate education of users
- Poor documentation system (Odisha State Open University, 2024)

Environmental factors

- Lack of serious consideration and adequate investment in this regard
- The lack of suitable use of mas media to develop the culture of using computer and information systems

- Inadequate appraisal of environmental impact in MIS
- The lack of standard procedure and methodology and stages in creatin the system (Odisha State Open University, 2024)

SUMMARY

This chapter deals with basic concept, meaning of information system and management information system. It also considered the role of MIS, its benefits, challenges, causes of its weaknesses. The chapter defined MIS as an analytical tool that enables the integration of data from different business applications, Internet, different modules and business functions. It converts data from internal and external sources into information. This information is communicated in an appropriate form to managers at different levels in a business to enable them to make effective decisions. Meanwhile, information system is seen as an integrated framework designed for the collection, storage, processing, and dissemination of data and information, encompassing physical elements like cards and digital products. The chapter discussed the importance of MIS in an organization and likened it as the heart in the human body. However, some challenges were also highlighted.

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Chapter 2

BRIEF HISTORY OF THE DEVELOPMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

[1]SULEIMAN, Adama Paris
Department of Business Education,
Federal College of Education, Yola
E-mail: adamasuleimanparis@gmail.com, +2348063724880

[2]OLADELE, Oluwabukola Margaret
Department of Anatomy, University of Ilesa, Osun State
E-mail: oladeleoluwabukola6@gmail.com, +2347063734786

[3]BAMBI, Babatunde Ishola
Academic Planning Unit, West Midlands Open University, Lagos
OrcidID: https://orcid.org/0009-0009-2236-8715
E-mail: bambi.babatunde@westmidlands.university
**Corresponding author contact number: +2348063462190*

1.0 INTRODUCTION

The development of Information and Communication Technology (ICT) has undergone a rapid and transformative evolution over the past few decades, significantly altering the way individuals, organizations, and societies operate. ICT refers to the integration of telecommunications, computers, and other digital tools to access, store, transmit, and manipulate information. It encompasses a wide range of technologies such as the internet, wireless networks, cell phones, and other communication mediums (Rouse, 2016). The origins of ICT can be traced back to the 19th century, during which time early innovations such as the telegraph and telephone paved the way for modern communication technologies. By the mid-20th

century, the invention of the transistor and the development of early computers marked a turning point. These innovations laid the groundwork for the digital age, enabling the processing of large amounts of information and facilitating the rise of modern telecommunications (Pérez & Kulesz, 2017). The subsequent invention of the internet in the late 1960s and early 1970s further revolutionized global communication, allowing for the seamless exchange of information across continents (Castells, 2015).

The 1990s witnessed what is often referred to as the "Digital Revolution," a period marked by the rapid spread of personal computers and the commercialization of the internet. With the advent of the World Wide Web in 1991, individuals and organizations gained unprecedented access to global information (Berners-Lee, 2019). This era also saw the emergence of software companies such as Microsoft and the development of graphical user interfaces, which made computing more accessible to non-technical users (Valenduc & Vendramin, 2016). The rapid adoption of these technologies fundamentally changed the business environment, education systems, and social interactions worldwide. The turn of the 21st century introduced a new phase of ICT development, characterized by the convergence of various digital technologies. Mobile technologies, particularly smartphones, became widespread, enabling users to access the internet and digital content from virtually anywhere. Cloud computing, artificial intelligence (AI), and big data analytics have since transformed how information is stored, processed, and utilized (Gartner, 2020). These advancements have led to the growth of industries such as e-commerce, e-learning, and telemedicine, reshaping how services are delivered globally.

Moreover, the growth of social media platforms has created new ways for individuals to communicate and share information in real-time (McChesney, 2015). Platforms such as Facebook, Twitter, and Instagram have become essential components of modern ICT

infrastructure, influencing everything from personal relationships to political movements. The COVID-19 pandemic, which began in 2019, further accelerated the adoption of ICT tools, particularly in the education and business sectors (Garrido, Ruiz & Miranda, 2021). The shift toward remote work and online learning has highlighted the critical role of ICT in maintaining connectivity in times of crisis. Despite the enormous potential of ICT, there are still several challenges that need to be addressed. Issues such as the digital divide, cybersecurity threats, and data privacy concerns remain prevalent (Bélanger & Crossler, 2019). The digital divide, in particular, highlights the gap between those who have access to modern ICT tools and those who do not, especially in developing regions of the world (World Bank, 2020).

Looking to the future, emerging technologies such as the Internet of Things (IoT), 5G networks, and blockchain promise to further expand the capabilities of ICT. These technologies have the potential to enhance automation, improve global connectivity, and offer new solutions to longstanding challenges in areas such as healthcare, education, and governance (Mitra, 2021). However, their successful implementation often depends on addressing current challenges and ensuring that technological advancements are inclusive and sustainable. Therefore, the thorough study in this paper offers a basis for comprehending the global historical perspective of ICT growth. The discourse also shows the constantly changing character of global technology development and its significant influence on civilisation. From early mechanical devices to contemporary digital systems, the development of ICT represents a constant search for innovation and improvement, which has so much influenced our way of life, business, and interaction in the digital age.

2.0 CONCEPT, COMPONENTS, BENEFITS AND CHALLENGES OF ICT

ICT is a broad and evolving concept that encompasses various digital technologies designed to store, retrieve, transmit, and process information. ICT integrates several fields of technology, including telecommunications, computing, and broadcasting, into a unified framework to facilitate the effective exchange of information across distances and time (Rouse, 2016). In modern society, ICT serves as the foundation for digital communication, information sharing, and innovative service delivery, transforming industries, economies, and education systems globally (Castells, 2015). Hence, the concept of ICT is diverse, as it consists of both hardware and software components that work together to enable information processing and communication. The important elements of ICT include:

1. **Hardware**: Physical devices such as computers, smartphones, tablets, and servers that store, process, and display information.
2. **Software**: Programs and applications that instruct hardware on how to perform tasks, including operating systems, word processors, and digital communication tools like email (Pérez & Kulesz, 2017).
3. **Networking**: The infrastructure that allows devices to communicate, including the internet, wireless technologies (Wi-Fi), and telecommunications networks (Valenduc & Vendramin, 2016).
4. **Digital Communication Tools**: Social media, email, video conferencing platforms, and other tools that facilitate real-time or asynchronous communication (McChesney, 2015).

These components work in concert to enable the transmission of data and information over long distances, providing the foundation for ICT applications in diverse areas such as e-commerce, telemedicine, education, and governance (Mitra, 2021). Thus, ICT has become a

driving force in both personal and professional settings. It has transformed how individuals interact, conduct business, and access information. In the educational sector, ICT tools are now indispensable for facilitating online learning, virtual classrooms, and digital collaboration (Garrido, Ruiz, & Miranda, 2021). Additionally, ICT plays a vital role in the global economy by streamlining business operations, enhancing productivity, and enabling remote work, especially in response to crises like the COVID-19 pandemic (World Bank, 2020). Moreover, ICT fosters social inclusion by providing platforms for marginalized groups to access information and engage in digital spaces. Social media and mobile technology have also revolutionized how political movements and social causes are mobilized, allowing for real-time engagement and global visibility (Castells, 2015).

While ICT offers numerous benefits, it also presents significant challenges. The digital divide, which refers to the disparity in access to ICT resources between different regions and social groups, remains a major concern (World Bank, 2020). Many developing countries still struggle with limited access to internet connectivity, affordable digital devices, and ICT infrastructure (Pérez & Kulesz, 2017). This gap exacerbates inequalities in education, healthcare, and economic opportunities. Furthermore, data security and privacy are ongoing issues in the ICT landscape. With the increasing reliance on digital platforms, safeguarding personal and organizational data from cyber threats has become critical (Bélanger & Crossler, 2019). However, technological advancements such as artificial intelligence (AI), the Internet of Things (IoT), and blockchain hold the potential to further enhance the capabilities of ICT and address some of these challenges (Mitra, 2021).

3.0 HISTORY OF DATA COLLECTION AND PROCESSING

The history of data collection and processing is a long and dynamic evolution, shaped by technological advancements, growing data

needs, and shifts in societal structures. Data collection and processing refer to the methods and tools used to gather, store, and analyse information for various purposes, such as decision-making, research, and technological development. From manual systems in ancient times to modern digital methods, the techniques used to collect and process data have continually transformed over time. These transformations include:

3.1 Early Beginnings of Data Collection

The practice of data collection dates back thousands of years, as early civilizations recognized the need to gather and record information for governance, trade, and agriculture. The earliest forms of data collection involved manual recording of information, such as census data, land ownership records, and tax information. One of the most notable examples is the use of clay tablets in Mesopotamia around 3000 BCE, which helped in organizing and managing data related to economic transactions (Yates, 2017). These early records, while rudimentary, laid the foundation for more sophisticated data collection methods.

3.2 The Industrial Revolution and the Rise of Mechanized Data Processing

The Industrial Revolution in the 18th and 19th centuries marked a significant turning point in the history of data collection and processing. With the growth of industries and large-scale enterprises, there was an increasing need to manage massive amounts of data related to production, labour, and supply chains. This gave rise to mechanical data processing systems. For example, in 1890, Herman Hollerith invented the punched card system, which was first used by the U.S. Census Bureau to efficiently process census data (Ceruzzi, 2015). This system reduced the time needed for data processing and became the precursor to modern computing systems.

3.3 The Advent of Electronic Computing

The mid-20th century saw a profound shift with the invention of electronic computers. These devices revolutionized how data was collected, stored, and processed. In 1946, the Electronic Numerical Integrator and Computer (ENIAC), one of the first electronic general-purpose computers, was introduced (Ceruzzi, 2015). ENIAC was capable of processing large amounts of data much faster than manual or mechanical systems. The rise of digital computing in the 1950s and 1960s further accelerated the ability to process vast datasets, allowing businesses, governments, and researchers to perform more complex analyses and make data-driven decisions.

3.4 The Information Age and Big Data

The development of personal computers in the 1970s and the advent of the internet in the 1990s brought the world into the Information Age. These technologies democratized data collection and processing, making it easier for individuals and organizations to gather and analyse data on an unprecedented scale (Mayer-Schönberger & Cukier, 2017). During this period, data processing moved from batch processing systems, which were often slow and inefficient, to real-time systems that enabled users to interact with and analyse data almost instantaneously.

The early 21st century saw the rise of "big data"—large and complex datasets generated from multiple sources, including social media, sensors, and mobile devices. Big data analytics allowed for the extraction of meaningful patterns from these enormous datasets using advanced algorithms and computing power (Sivarajah et al., 2017). As organizations began to collect more data than ever before, the focus shifted to how this data could be effectively processed and utilized to generate insights.

3.5 Modern Data Collection and Processing Technologies

Today, data collection and processing are highly sophisticated, relying on digital technologies such as artificial intelligence (AI), machine learning, cloud computing, and the Internet of Things (IoT). These technologies enable organizations to collect data from diverse sources in real-time and process it using powerful computational methods. AI and machine learning algorithms, for instance, are now being used to automatically process large amounts of data, identify patterns, and make predictions (Chen & Zhang, 2017). The cloud has also transformed how data is stored and processed by offering scalable solutions that allow organizations to manage data more flexibly and cost-effectively (Hashem et al., 2015).

IoT devices, such as smart sensors and wearable technologies, have expanded the scope of data collection to include real-time data from physical environments. These technologies allow for continuous data monitoring and processing in industries ranging from healthcare to agriculture (Sundmaeker et al., 2016). As data collection and processing systems evolve, new challenges such as data privacy, security, and ethical considerations have also emerged, requiring organizations to adopt stringent measures to protect sensitive data (Dehghani et al., 2020).

4.0 GLOBAL ECONOMIC AND SOCIETAL REVOLUTIONS DUE TO ICT

ICT has been a key driver of numerous revolutions that have shaped the modern world. These revolutions have not only transformed industries but also redefined societal structures, economies, and human capabilities. From the agricultural revolution to the ongoing information and human capital revolutions, ICT has played a pivotal role in accelerating innovation, enhancing productivity, and fostering global connectivity.

4.1 The Agricultural Revolution

While the first agricultural revolution occurred over 10,000 years ago, the modern agricultural revolution, often referred to as *Agriculture 4.0*, has been heavily influenced by ICT. The integration of ICT into agriculture has led to precision farming, where technologies such as sensors, drones, and GPS systems are used to monitor crops, soil health, and weather conditions in real-time (Wolfert et al., 2017). Additionally, data analytics and machine learning have enabled farmers to make data-driven decisions, improving efficiency and sustainability in food production. This transformation is helping to address global challenges such as food security and climate change by optimizing resource use and minimizing waste.

4.2 The Industrial Revolution

The first industrial revolution, which began in the late 18th century, was characterized by the mechanization of production using steam and water power. However, the modern world is now experiencing what is referred to as the *Industry 4.0*, largely driven by ICT. This revolution is marked by the convergence of digital, physical, and biological systems through technologies such as the Internet of Things (IoT), artificial intelligence (AI), robotics, and big data analytics (Schwab, 2017). Industry 4.0 is enabling smart factories where machines communicate with each other, leading to greater automation, efficiency, and customization of products. This transformation is reshaping manufacturing, supply chains, and labour markets, creating new economic opportunities while also raising concerns about job displacement.

4.3 The Information Revolution

The information revolution refers to the period from the late 20th century to the present, during which digital technologies became the primary means of communication, data processing, and information storage. ICT, particularly the advent of the internet and personal

computers, has been at the heart of this revolution, drastically changing how information is accessed, shared, and used. The rapid proliferation of the internet, mobile devices, and cloud computing has enabled real-time communication and the digitization of almost every aspect of human activity, from education to entertainment (Mayer-Schönberger & Cukier, 2017). The Information Revolution has democratized access to knowledge and empowered individuals and businesses to engage in the global economy.

4.4 The Human Capital Revolution

ICT is also driving a *Human Capital Revolution* by transforming how people acquire, manage, and apply knowledge and skills. Online education platforms, massive open online courses (MOOCs), and digital learning tools have made education and skill development more accessible and flexible (Levy, 2018). ICT has also enabled remote work, allowing people to contribute to the workforce from anywhere in the world, increasing opportunities for a global talent pool. This shift has been further accelerated by the COVID-19 pandemic, which highlighted the importance of digital tools in maintaining workforce productivity during crises (World Economic Forum, 2020). Moreover, AI and data analytics are being used to optimize talent management in organizations by analysing employee performance, predicting future needs, and providing personalized career development pathways (Cascio & Montealegre, 2016). As organizations become more reliant on technology, human capital is being reshaped by a greater emphasis on digital literacy and problem-solving skills.

4.5 The E-Commerce and Digital Economy Revolution

ICT has fundamentally changed the way commerce is conducted, leading to the rise of the *E-commerce and Digital Economy Revolution*. E-commerce platforms like Amazon, Alibaba, and eBay have enabled businesses to reach global markets, while digital payment systems, such as mobile banking and cryptocurrency, have

revolutionized financial transactions (McKinsey Global Institute, 2016). The use of big data, AI, and predictive analytics in e-commerce allows businesses to personalize customer experiences, streamline logistics, and forecast market trends with greater accuracy. Furthermore, ICT has facilitated the sharing economy, characterized by platforms such as Uber, Airbnb, and TaskRabbit, which use digital technologies to connect service providers with consumers. This model has disrupted traditional business structures and created new opportunities for entrepreneurship and economic participation (Sundararajan, 2016).

4.6 The Healthcare Revolution

The healthcare industry is undergoing a transformation due to ICT, leading to what is often referred to as the *Healthcare Revolution* or *Health 4.0*. The integration of digital tools such as electronic health records (EHRs), telemedicine, and wearable health devices has improved patient care by enabling real-time monitoring, data-driven diagnosis, and personalized treatment (Raghupathi & Raghupathi, 2017). Additionally, AI and machine learning are being used to analyse vast datasets from medical research, improving the speed and accuracy of drug discovery, disease diagnosis, and treatment plans. ICT is also facilitating global collaboration among healthcare professionals and researchers, which is crucial for tackling global health challenges such as pandemics and chronic diseases.

4.7 The Education Revolution

ICT is also revolutionizing education, leading to the rise of *Education 4.0*, where digital technologies are transforming how learning is delivered and accessed. With the development of online learning platforms, virtual classrooms, and educational software, students can now access learning materials from anywhere at any time (Peters, 2017). AI is also being used in education to provide personalized learning experiences, adapt teaching methods, and assess student progress. The Education Revolution is expanding access to quality

education, particularly for students in remote or underserved areas, and is creating new opportunities for lifelong learning.

5.0 OLD AND NEW INFORMATION TECHNOLOGIES

Information technologies (IT) have undergone significant transformations over time, evolving from basic tools for data storage and communication to advanced systems that drive nearly every facet of modern life. The progression from old to new information technologies reflects both technological advancements and changing societal needs. These technologies are central to information management, enabling the collection, processing, dissemination, and storage of data. The distinction between old and new IT provides insights into how technological innovations shape global communication, business, education, and everyday life.

5.1 Old Information Technologies

Old information technologies, which emerged during the 20th century, were the foundational systems that facilitated communication, data processing, and storage. They primarily included:

1. **Telegraph**: Developed in the early 1800s, the telegraph was one of the first significant IT breakthroughs, enabling long-distance communication through coded electrical signals (Standage, 2017).
2. **Radio and Television**: In the early 20th century, radio broadcasting became a popular medium for mass communication. Television followed in the 1930s, revolutionizing how information and entertainment were delivered to the public (Uricchio, 2016).
3. **Mainframe Computers**: Introduced in the 1950s and 1960s, mainframe computers were large, powerful machines used primarily by governments, research institutions, and large corporations for data processing (Ceruzzi, 2015). These computers used punched cards to input data and were

critical for tasks such as census data analysis and scientific research.

4. **Landline Telephones**: Fixed-line telephones became a ubiquitous communication tool in the mid-20th century, enabling voice communication over long distances. The development of telephone networks laid the groundwork for modern communication systems (Goggin, 2018).

Despite their innovations, old IT systems had significant limitations. They were often slow, required extensive infrastructure, and lacked the flexibility and user-friendliness that modern systems offer today. Additionally, old IT relied heavily on manual data input and processing, making them labour-intensive.

5.2 New Information Technologies

In contrast to the older systems, new information technologies represent a convergence of advanced computing, telecommunications, and digital media that have reshaped every aspect of communication and information management. These technologies are faster, more versatile, and far more accessible, allowing for real-time, global interactions.

a) **Personal Computers and Laptops**: The rise of personal computing in the 1980s and 1990s revolutionized how individuals and businesses interacted with information. Laptops extended the portability of computing, making it possible to work from virtually anywhere (Bellis, 2020).
b) **The Internet**: The most transformative new IT is undoubtedly the internet, which began as a network of military and academic institutions in the 1960s and evolved into a global system for sharing information in the 1990s. The internet underpins most modern communication, business, and entertainment platforms (Leiner et al., 2017).
c) **Mobile Technology**: Mobile phones, especially smartphones, have become ubiquitous in the 21st century.

These devices integrate computing, telecommunication, and multimedia into a portable format, offering real-time connectivity to the internet and applications (Poushter, 2016).

d) **Cloud Computing**: Cloud technologies have dramatically changed how data is stored and accessed. By allowing users to store and process data on remote servers rather than local devices, cloud computing offers scalability, cost-efficiency, and flexibility for both individuals and organizations (Hashem et al., 2015).

e) **Artificial Intelligence (AI) and Machine Learning**: AI technologies, including machine learning, are a cornerstone of modern IT. AI allows computers to learn from data, recognize patterns, and make decisions without explicit programming. These technologies are used in various industries, from healthcare to finance, and are embedded in consumer products like virtual assistants (Chen & Zhang, 2017).

f) **5G Networks and IoT**: The advent of 5G technology and the Internet of Things (IoT) has introduced faster, more reliable connectivity that can support billions of interconnected devices. This new IT infrastructure facilitates real-time data sharing across smart devices, vehicles, and industries, promoting automation and data-driven decision-making (Al-Fuqaha et al., 2015).

5.3 Comparing Old and New Information Technologies

While old information technologies laid the groundwork for modern systems, new information technologies have vastly expanded their potential. Old IT systems, such as landline telephones, mainframes, and early broadcast media, were limited in scope, primarily providing one-way or limited interaction channels. By contrast, new IT systems, such as the internet, smartphones, and cloud platforms,

offer interactive, multimedia-rich environments that foster global connectivity and collaboration.

i. **Scalability and Accessibility**: Old IT systems required significant infrastructure and were often restricted to specific locations, such as a central office or data centre. New IT technologies, especially cloud computing and mobile devices, offer scalable solutions accessible from anywhere with an internet connection (Hashem et al., 2015).
ii. **Speed and Efficiency**: Old IT systems were relatively slow and inefficient compared to modern technologies. Mainframe computers, for instance, required significant time for data processing, while modern AI systems can process complex datasets in real-time (Chen & Zhang, 2017).
iii. **User Experience**: Old IT systems often required specialized knowledge to operate. In contrast, new technologies prioritize user-friendliness and accessibility, with intuitive interfaces that enable a broader range of users to engage with digital platforms (Leiner et al., 2017).

5.4 The Future of Information Technologies

As ICT continues to evolve, new IT systems will likely become even more integrated into daily life. Technologies such as quantum computing, augmented reality (AR), and 6G networks are already being researched and developed, promising further advancements in data processing, communication, and connectivity (Misra & Soni, 2020). These innovations could revolutionize industries like healthcare, education, and manufacturing, as well as personal communication and entertainment.

6.0 THE GENERATIONS OF COMPUTERS

The development of computers over the past century can be categorized into distinct generations, each marked by technological advancements that enhanced processing power, efficiency, and accessibility. These generations are defined by the introduction of

new hardware and software technologies, starting from the first mechanical computers to today's advanced microprocessor-based systems. Understanding the generations of computers provides insight into how the technology has evolved and shaped modern computing.

6.1 First Generation (1940-1956): Vacuum Tubes

The first generation of computers was characterized by the use of vacuum tubes as the primary technology for processing and memory. These machines were large, consumed a lot of power, and generated significant heat, which often caused operational problems (Ceruzzi, 2015). Computers like the ENIAC (Electronic Numerical Integrator and Computer), developed in the 1940s, are examples of first-generation machines. The input for these computers was primarily through punched cards and paper tape, while output was displayed on printouts. The key characteristics include: (i) use of vacuum tubes, (ii) magnetic drums for memory, (iii) machine language programming (binary) and (iv) a high-power consumption and large physical size. Though groundbreaking at the time, these computers were slow by today's standards, with processing speeds measured in milliseconds.

6.2 Second Generation (1956-1963): Transistors

The invention of the transistor in 1947 marked a significant breakthrough, leading to the second generation of computers. Transistors replaced vacuum tubes, making computers smaller, faster, and more energy-efficient. Transistor-based computers were more reliable and generated less heat, reducing operational issues (Bellis, 2020). Additionally, these computers introduced the use of assembly language, which made programming more efficient than machine language. The key characteristics include: (i) the use of transistors instead of vacuum tubes, (ii) magnetic core memory for data storage, (iii) high-level programming languages like FORTRAN and COBOL, and (iv) increased reliability and efficiency. During this period, computers became more widely used in industries and scientific research due to their enhanced capabilities and reduced costs.

6.3 Third Generation (1964-1971): Integrated Circuits

The third generation of computers saw the introduction of integrated circuits (ICs), which combined multiple transistors onto a single silicon chip. This innovation drastically increased computing power and efficiency while reducing the size of computers even further (Ceruzzi, 2015). ICs allowed for the development of more sophisticated software and operating systems, which contributed to the increased usability of computers across different sectors. The key characteristics include: (i) the use of integrated circuits, (ii) introduction of multitasking and time-sharing systems, (iii) use of keyboards and monitors for input and output, and (iv) smaller, faster, and more affordable computers. Integrated circuits revolutionized the computing industry, enabling the development of minicomputers and laying the groundwork for personal computers.

6.4 Fourth Generation (1971-Present): Microprocessors

The fourth generation of computers began with the invention of the microprocessor, a complete central processing unit (CPU) on a single chip, by Intel in 1971. Microprocessors allowed computers to be smaller, more powerful, and more affordable, leading to the widespread adoption of personal computers (PCs) (Hashem et al., 2015). This generation also saw the rise of graphical user interfaces (GUIs), making computers more accessible to non-technical users. The key characteristics include: (i) the use of microprocessors for data processing, (ii) development of personal computers and laptops, (iii) increased use of GUIs and development of advanced software applications, and (iv) growth of computer networking and the internet. The advent of microprocessors marked the era of mass-market computing, making computers ubiquitous in homes, offices, and educational institutions. Companies like Apple and Microsoft played crucial roles in popularizing personal computers.

6.5 Fifth Generation (Present and Beyond): AI and Quantum Computing

The fifth generation of computers is defined by the incorporation of artificial intelligence (AI) and quantum computing. AI technologies, including machine learning and natural language processing, are being integrated into modern computers, allowing them to perform complex tasks such as image recognition, speech processing, and decision-making (Chen & Zhang, 2017). Meanwhile, quantum computing represents a significant leap forward in processing power, using quantum bits (qubits) to perform computations that are impossible for traditional computers. The key characteristics include: (i) the integration of AI and machine learning technologies, (ii) development of quantum computing for complex problem-solving, (iii) increased automation and real-time data processing capabilities, and (iv) use of advanced software systems for big data and analytics. AI-powered computers are increasingly being used in various sectors, including healthcare, finance, and education, to improve decision-making, optimize processes, and solve complex problems. Quantum computing, while still in its early stages, has the potential to revolutionize fields such as cryptography, materials science, and drug discovery (Misra & Soni, 2020).

7.0 Defining Technology and Information Technology

Technology and information technology (IT) are two closely related concepts that play pivotal roles in shaping modern societies. While "technology" is a broad term encompassing tools, systems, and processes used to solve problems or achieve goals, "information technology" is a specific subset focusing on the use of computers and telecommunications to store, retrieve, transmit, and manipulate data. Understanding the definitions and implications of both concepts is essential for appreciating their impact on various sectors, from business and education to healthcare and communication.

7.1

7.2 Defining Technology

Technology refers to the application of scientific knowledge for practical purposes, especially in industry. It encompasses a wide range of tools, machines, techniques, systems, and methods that humans develop and use to manipulate their environment or achieve specific objectives. According to Arthur (2009), technology is "a means to fulfil a human purpose." This can include tangible items like machines and tools, as well as intangible methods such as scientific processes or algorithms. The evolution of technology is ongoing, driven by human needs and the pursuit of efficiency and innovation.

Technology spans a variety of domains, including agriculture, construction, transportation, medicine, and communication. It is not limited to mechanical devices; rather, it involves both hardware (physical artifacts) and software (intangible systems like programs and procedures) (Grau, 2020). One of the key elements of technology is that it is often used to increase productivity and improve quality of life. For instance, the development of medical technologies such as MRI machines has drastically improved diagnostic accuracy, while advancements in agricultural technologies have enhanced food production and distribution. However, technology can also bring challenges, such as environmental degradation or job displacement due to automation (Kostoff et al., 2021).

7.2 Defining Information Technology (IT)

Information technology (IT) is a subset of technology focused on the processing, storage, and communication of information using electronic systems. The primary focus of IT is on the application of computers and telecommunications equipment to store, retrieve, and transmit data (Hashem et al., 2015). IT encompasses both hardware (computers, servers, networking devices) and software (programs, databases, and applications) used for these purposes. IT includes a range of technologies designed to process information. These elements include:

- **Hardware**: Physical devices such as servers, computers, networking equipment, and storage devices.
- **Software**: Applications and operating systems that enable users to interact with data and manage resources.
- **Telecommunications**: The infrastructure for transmitting data over networks, including the internet and mobile communication systems.
- **Data Management**: The organization, storage, and retrieval of information in databases or cloud systems (Laudon & Laudon, 2021).

The significance of IT has increased exponentially with the advent of the digital age. IT systems are the backbone of modern business, healthcare, education, and government operations. The automation of processes, real-time communication, and data analytics are just a few examples of how IT enhances efficiency, decision-making, and innovation (Morabito, 2016).

7.3 The Relationship Between Technology and Information Technology

While technology is an umbrella term encompassing a wide range of inventions and processes, IT focuses specifically on the use of digital tools to manage information. Information technology is a critical subset of technology, particularly in the modern digital economy where data is a central resource.

- **Technology as the Foundation for IT**: Information technology relies on broader technological advancements. For instance, the invention of the microprocessor in the 1970s was a key technological development that enabled the modern IT industry to flourish (Bellis, 2020). Similarly, advancements in telecommunications technologies, such as fibre optics and 5G networks, provide the infrastructure that enables IT systems to function globally.

- **The Impact of IT on Technology**: Conversely, advancements in IT have also influenced the broader field of technology. The use of data analytics, artificial intelligence (AI), and machine learning, for instance, has accelerated technological innovations in fields like healthcare, engineering, and environmental management (Chen & Zhang, 2017). IT systems enable faster research, development, and implementation of new technologies across a range of sectors.

7.4 Technologies Merged to Form ICT

Information and Communication Technology (ICT) is an umbrella term that refers to the convergence of various technologies that enable the creation, storage, retrieval, and dissemination of information. It encompasses both information technology (IT) and communication technology, creating a dynamic framework for handling data in digital formats and across networks. The convergence of these technologies has revolutionized industries, education, healthcare, and personal communication, making ICT indispensable in the modern world.

7.4.1 Information Technology (IT)

Information technology forms one half of the ICT framework. IT deals with the use of computers and software to manage data. Over the years, IT has evolved significantly, incorporating hardware developments such as microprocessors, memory storage devices, and peripheral devices, as well as software technologies like operating systems and databases. IT allows for efficient data storage, processing, and retrieval, and its integration with communication technologies has enhanced the accessibility of information across the globe (Laudon & Laudon, 2021). The component of IT include:

a) **Computing Systems**: Computers, laptops, and mobile devices form the hardware foundation of IT. These devices

provide the processing power needed for complex calculations and data management.

b) **Software**: Operating systems (like Windows, macOS, and Linux), application software (such as word processors and databases), and utility programs contribute to the core of IT infrastructure.

c) **Data Storage**: Cloud storage, hard drives, and other storage solutions allow for the safekeeping and retrieval of vast amounts of data.

7.4.2 Communication Technology

Communication technology refers to the systems used to transmit information between devices and people across distances. Historically, communication technology included telegraphs, telephones, and radio, but the advent of digital technologies has drastically expanded its capabilities. Modern communication technologies include the internet, mobile networks, satellite systems, and wireless communication. These technologies enable real-time communication, information sharing, and connectivity across geographical boundaries (Chen & Zhang, 2017). The key components of communication technology are:

i. **Telecommunications Networks**: The internet, local area networks (LANs), wide area networks (WANs), and mobile networks enable data transmission. These networks use cables, fibre optics, and wireless technologies to connect devices.

ii. **Protocols**: Communication technologies rely on protocols such as TCP/IP, HTTP, and HTTPS, which define how data is transmitted over networks and the internet.

iii. **Devices**: Smartphones, routers, satellites, and modems serve as conduits for transmitting and receiving data, making real-time communication possible.

By merging IT with communication technology, ICT enables rapid data transmission and real-time interaction across multiple platforms.

8.0 SUMMARY

The development of ICT traces its origins to a series of innovations over centuries, beginning with the creation of early computing machines like the abacus and mechanical calculators. The real transformation began with the invention of the transistor in the 1940s, leading to the development of mainframe computers and eventually personal computers. The rise of the internet and mobile communication in the late 20th century significantly accelerated the growth of ICT, making information more accessible and communication instantaneous. From basic data processing tools to today's cloud computing and artificial intelligence systems, ICT has become integral to almost every aspect of life. ICT, a combination of information technology and communication technology, refers to the systems used to handle information in digital formats. It encompasses hardware, software, networks, and protocols that enable data storage, retrieval, transmission, and communication. ICT systems have become essential for various industries, enhancing productivity, fostering innovation, and enabling remote communication and collaboration. In a digital economy, ICT is key in fields such as business, education, healthcare, and governance.

Data collection and processing have evolved from manual methods like tallying and bookkeeping to automated systems powered by computers. Initially, data processing involved punch cards and mainframe computers, which later evolved into more sophisticated databases and software applications. With the advent of big data and cloud computing, data collection has become more extensive, enabling real-time analysis and insights. Modern tools allow for large-scale processing and the use of artificial intelligence and machine learning to derive insights from vast datasets. ICT has been central to numerous technological and societal revolutions. The

Agricultural Revolution saw the adoption of machinery and data systems to increase crop yields. The Industrial Revolution was followed by the Information Revolution, where ICT tools facilitated automation, global communication, and the digitalization of industries. In the current era, ICT is driving the Human Capital Revolution, enhancing education, workforce management, and innovation through tools like e-learning platforms, AI, and data analytics. The ongoing Artificial Intelligence (AI) Revolution further emphasizes the transformative potential of ICT in every sector.

Old information technologies, including telegraphs, typewriters, and landline telephones, laid the groundwork for modern systems by enabling basic communication and data management. These technologies were characterized by limited capabilities in terms of speed and accessibility. New information technologies, such as cloud computing, mobile networks, and AI, have radically transformed the way information is processed, stored, and communicated. New technologies offer real-time access, vast storage capacities, and improved data security. The shift from analogy to digital systems marks a significant leap in efficiency and capabilities. The development of computers is categorized into five generations, each defined by technological advancements. Also, technology is broadly defined as tools, processes, or systems that solve problems or achieve objectives. Information Technology (IT) is a subset of technology that focuses specifically on managing and processing information using computers and telecommunications systems. While technology can refer to everything from machinery to digital applications, IT specifically addresses how data is stored, processed, and communicated, forming the backbone of today's digital economy. Finally, several core technologies have merged to form the ICT framework, such as Information Technology (IT), which is the use of computers and software for data management, storage, and processing and Communication Technology (the systems used for transmitting information, including telephones, internet, and mobile

networks). Together, these technologies enable the seamless integration of communication and data management, revolutionizing how information is accessed and utilized.

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Chapter 3

INFORMATION SYSTEMS IN ORGANIZATIONS

Philemon Hananiya, Kabiru Mohammed Badau, Francis Olajire Awodoyin & Yidawi Musa Inusa
Department of Physical Sciences Education, Faculty of Education, Modibbo Adama University, Yola

Corresponding email: E-mail: hananiyaphilemon@gmail.com

INTRODUCTION

Information Systems (IS) are integral to modern organizations, serving as the backbone for managing operations, making decisions, and gaining competitive advantages. These systems encompass a combination of technology, people, and processes designed to collect, process, store, and distribute information. IS consist of five key components: hardware, software, data, people, and processes. Hardware includes the physical devices required for input, processing, and output activities. Software refers to the programs and applications that manage hardware operations. Data is the raw material processed into meaningful information. People, including IT professionals and end-users, interact with IS to perform tasks and make decisions. Finally, processes are the methodologies and workflows that guide the operation and integration of these components to achieve organizational objectives (Englander & Wong, 2021).

The goal of Information Systems (IS) is to improve the efficiency and effectiveness of business operations, streamline communications, and facilitate problem-solving and decision-making across various levels of an organization (Awulor, Mallam-Obi & Chukwu, 2022). However, the role of IS in organizations extends beyond simple data

processing; it is critical for strategic planning, operational efficiency, and competitive advantage. IS supports various business functions such as marketing, finance, human resources, and supply chain management by providing timely and accurate information. This support enables organizations to respond swiftly to market changes, optimize resource allocation, enhance customer service, and innovate their products and services (Fu, Abdul Rahman, Jiang, Abbas & Comite, 2022).

The evolution of Information Systems has been marked by rapid technological advancements and increasing integration within business strategies. From early mainframe computers to contemporary cloud computing and artificial intelligence, IS has continuously adapted to meet growing and complex organizational needs. Current trends such as big data analytics, the Internet of Things (IoT), and blockchain technology are reshaping how organizations gather insights, make decisions, and secure information. As it were, Information Systems is the blood stream of educational administration (Pearlson, Saunders & Galletta, 2024).
Information Systems (IS) in educational administration are comprehensive frameworks designed to manage, process, and distribute information within educational institutions. These systems include a variety of technologies and applications aimed at optimizing administrative tasks, improving communication, and aiding decision-making processes. By automating routine activities and offering real-time access to essential data, IS greatly enhance the efficiency and effectiveness of educational administration (Ismagilova, Hughes, Dwivedi & Raman, 2019).

Information Systems offer numerous benefits to educational institutions by enhancing operational efficiency and decision-making capabilities. They enable the automation of administrative tasks such as enrollment, scheduling, grade reporting, and resource allocation, thereby reducing manual workload and minimizing errors.

Information Systems also facilitate improved communication between students, faculty, and administrative staff, fostering a more collaborative and responsive educational environment. Additionally, they provide valuable insights through data analytics, supporting evidence-based decision-making and strategic planning (Osborne, Byrne, Massey, & Johnston, 2018).

The evolution of Information Systems in education administration has been driven by advancements in technology and increasing demands for digital transformation in education. From basic record-keeping systems to sophisticated cloud-based platforms, IS have continuously adapted to meet the growing needs of educational institutions. Current trends include the adoption of artificial intelligence (AI) for personalized learning, blockchain for secure credentialing, and big data analytics for predictive insights. These technologies are reshaping how educational institutions manage information and deliver services (Succi & Canovi, 2020).

Despite the advantages, implementing and maintaining IS in education administration comes with challenges. Issues such as data privacy, cybersecurity, and compliance with regulations are critical concerns. Educational institutions must also address the complexities of system integration, user training, and change management. Ensuring that IS are user-friendly and meet the diverse needs of all stakeholders requires ongoing evaluation and adaptation. By proactively managing these challenges, educational institutions can fully leverage the potential of IS to enhance administrative efficiency and improve educational outcomes.

DEFINITION OF INFORMATION

Technical Perspective

From a technical perspective, information is data that has been processed and organized in a manner that adds value by providing context, relevance, and purpose. It is the result of computational and

data management processes that convert raw data into meaningful and useful insights, often involving the application of algorithms and analytics to transform and interpret data (Taylor & Crocker, 2022).

Organizational Perspective

In the context of an organization, information is a strategic resource that supports decision-making, operational efficiency, and competitive advantage. It encompasses all the knowledge and data assets that are essential for the functioning and strategic planning of an organization. This perspective views information as a critical component that flows across various departments, enabling coordination and integration of activities (Wu, Tseng, Chiu & Lim, 2017).

Cognitive Perspective

From a cognitive standpoint, information is the knowledge that individuals acquire, process, and utilize to make sense of the world and inform their actions. It is the processed data that humans perceive, interpret, and integrate into their cognitive frameworks, helping them to understand and interact with their environment effectively. This perspective emphasizes the role of information in learning, reasoning, and problem-solving (Gee, 2018).

Economic Perspective

Economically, information is considered a valuable commodity and asset that can drive economic activities and growth. It is often seen as an intangible resource that holds value when used to improve products, services, and business processes. Information in this sense can reduce uncertainty, enhance decision-making, and provide competitive advantages in markets.

Social Perspective

From a social perspective, information is the shared knowledge and communication that facilitates human interaction and societal functions. It includes the exchange of ideas, cultural norms, and social practices that help build communities and shape public opinion. This perspective highlights the role of information in fostering social cohesion, influencing behavior, and driving social change (Frenken & Schor, 2019).

DEFINITION OF INFORMATION SYSTEM

Technically, an Information System (IS) is a coordinated set of hardware, software, data, people, and processes designed to collect, process, store, and disseminate information. This system enables the efficient and effective management of data and supports decision-making and control in an organization by converting raw data into useful information through automated processes (Laudon & Laudon, 2017).

From an organizational perspective, an Information System is an integrated platform that supports the core activities and strategic goals of a business or institution. It facilitates communication, streamlines operations, and enhances productivity by ensuring that accurate and timely information flows seamlessly across different departments and functional areas. IS encompasses various subsystems tailored to specific administrative, financial, or operational needs within the organization (Pearlson, Saunders & Galletta, 2024).

Functionally, an Information System is a tool that aids in the execution of business processes and decision-making tasks. It serves as a repository and processor of data, transforming inputs into meaningful outputs such as reports, analyses, and visualizations. By providing actionable insights and supporting data-driven decisions, IS helps organizations achieve efficiency, competitive advantage, and

innovation in their operations (Aydiner, Tatoglu, Bayraktar & Zaim, 2019).

MANAGEMENT FUNCTIONS

Planning

Planning is the foundational function of management, involving the formulation of objectives and the determination of the best course of action to achieve them. This process includes analyzing current situations, anticipating future conditions, and deciding on activities necessary to reach goals. Effective planning helps organizations set priorities, allocate resources efficiently, and prepare for potential challenges. It ensures that all organizational efforts are aligned with strategic objectives and provides a roadmap for achieving desired outcomes (Bryson, 2018).

Organizing

Organizing involves arranging resources and tasks in a structured manner to achieve the organization's goals. This function includes developing an organizational structure, defining roles and responsibilities, and coordinating activities across different departments. By establishing clear lines of authority and communication, organizing ensures that resources are used effectively and that employees understand their roles within the organization. This process also involves the allocation of physical, financial, and human resources to different projects and functions (Agarwal, & Sambamurthy, 2020).

Leading

Leading, or directing, is the management function that involves motivating and guiding employees to achieve organizational goals. This includes setting a vision, communicating effectively, and inspiring employees to perform at their best. Leadership

encompasses various activities such as making decisions, resolving conflicts, and fostering a positive organizational culture. Effective leaders build strong teams, create an environment of trust and collaboration, and drive organizational success by aligning individual and group efforts with the organization's objectives (Andriani, Kesumawati, & Kristiawan, 2018).

Controlling

Controlling is the process of monitoring and evaluating the progress of an organization towards its goals. This function involves setting performance standards, measuring actual performance, and taking corrective actions when necessary. Through controlling, managers ensure that organizational activities are on track and that deviations from plans are identified and addressed promptly. This function provides feedback on the effectiveness of planning, organizing, and leading, enabling continuous improvement and adaptation to changing circumstances (Otley & Berry, 2019).

Coordinating

Coordinating is the management function that ensures all parts of the organization work together harmoniously to achieve common objectives. This involves synchronizing activities, resolving interdepartmental conflicts, and facilitating communication between different parts of the organization. Effective coordination ensures that resources are used efficiently and that organizational efforts are integrated and aligned. By fostering collaboration and ensuring that all organizational activities are mutually reinforcing, coordination helps achieve synergy and enhances overall performance (Agarwal & Sambamurthy, 2020).

INFORMATION AND DECISION MAKING

Information plays a crucial role in the decision-making process by providing the necessary data and context for evaluating options and making informed choices. High-quality, relevant, and timely

information allows decision-makers to understand the current situation, identify problems, predict future trends, and assess the potential outcomes of different courses of action. Without accurate information, decision-making becomes a process of guesswork, increasing the risk of errors and poor outcomes. Effective decision-making relies on having comprehensive and reliable information that supports the evaluation of alternatives and the selection of the best possible solution (Intezari & Gressel, 2017).

Types of Information Used in Decision Making

Different types of information are utilized in decision-making, including qualitative and quantitative data, internal and external information, and historical and real-time data. Quantitative data, such as statistics and metrics, provide measurable evidence that can be analyzed to identify patterns and trends. Qualitative information, such as expert opinions and case studies, offers insights that help interpret quantitative data and provide context. Internal information pertains to data within the organization, like financial records and employee performance, while external information includes market trends, competitor analysis, and regulatory changes. Both historical data, which provides a record of past performance, and real-time data, which reflects current conditions, are essential for making well-rounded decisions.

Information Systems in Supporting Decision Making

Information Systems (IS) are vital tools that support decision-making by collecting, processing, and presenting information in a structured manner. IS, such as Decision Support Systems (DSS), Management Information Systems (MIS), and Executive Information Systems (EIS), provide decision-makers with timely and relevant information. These systems enable the analysis of large volumes of data, the simulation of different scenarios, and the visualization of complex information through dashboards and reports. By integrating data from various sources and offering analytical capabilities, IS enhance the accuracy

and efficiency of the decision-making process, helping organizations make better-informed decisions.

Decision-Making Models and Information Requirements

Different decision-making models require varying types and levels of information. For example, the rational decision-making model involves a systematic analysis of information to evaluate all possible alternatives before selecting the optimal solution. This model requires comprehensive, accurate, and detailed information to compare the costs and benefits of each option. On the other hand, the bounded rationality model recognizes that decision-makers often operate under constraints such as limited information, time, and cognitive capacity, leading to satisficing rather than optimizing decisions. In this context, information needs to be relevant and sufficient to make a satisfactory choice without exhaustive analysis.

Challenges in Information-Based Decision Making

While information is essential for effective decision-making, several challenges can impede its optimal use. Information overload, where decision-makers are overwhelmed by excessive data, can lead to analysis paralysis and hinder timely decisions. Ensuring the accuracy and reliability of information is another critical challenge, as flawed or biased data can result in poor decisions. Additionally, the dynamic nature of information, with frequent updates and changes, requires continuous monitoring and adaptation. Decision-makers must also navigate issues related to data privacy, security, and ethical considerations when using information. Addressing these challenges involves implementing robust information management practices, utilizing advanced analytics, and fostering a culture that values data-driven decision-making.

Decision Models in Organizations

Rational Decision-Making Model

The rational decision-making model is a systematic and logical approach to decision-making, based on the assumption that decision-makers are fully informed and able to evaluate all possible options to choose the best one. This model involves a multi-step process: identifying the problem, gathering relevant information, generating alternative solutions, evaluating each alternative, and selecting the optimal solution. The strength of this model lies in its structured methodology, which aims to maximize the effectiveness and efficiency of decisions. However, its practicality can be limited by constraints such as time, information availability, and the cognitive limitations of decision-makers.

Bounded Rationality Model

The bounded rationality model, developed by Herbert Simon, acknowledges that decision-makers operate under constraints that limit their ability to process information and make fully rational decisions. These constraints include limited cognitive resources, incomplete information, and time pressures. Instead of striving for the optimal solution, decision-makers using this model seek a satisfactory or "good enough" solution. The bounded rationality model reflects the reality of organizational decision-making more accurately than the rational model, recognizing that decisions are often made with heuristics and rules of thumb. This approach balances the need for a reasonable decision with the practical limitations faced by individuals and organizations.

Incremental Decision-Making Model

The incremental decision-making model, also known as the "muddling through" approach, suggests that decisions are made through small, gradual changes rather than large, comprehensive transformations. This model is based on the idea that decision-

makers often deal with complex and uncertain environments where comprehensive analysis is impractical. Instead, they make decisions by building on previous actions and making small adjustments as new information becomes available. This iterative process allows organizations to be flexible and adaptive, reducing the risk associated with major changes. However, it can also lead to suboptimal solutions if incremental changes fail to address underlying problems.

Political Decision-Making Model

The political decision-making model emphasizes the role of power, influence, and negotiation in organizational decisions. This model recognizes that organizations are composed of individuals and groups with different interests, goals, and levels of power. Decision-making is often a result of bargaining, coalition-building, and compromise among these stakeholders. This model highlights the importance of understanding the political dynamics within an organization and how they impact decisions. While it provides a realistic view of how decisions are made, it can also lead to decisions that reflect the interests of the most powerful stakeholders rather than the best interest of the organization as a whole.

Garbage Can Model

The garbage can model of decision-making, proposed by Cohen, March, and Olsen, describes a more chaotic and less structured approach to decision-making in organizations. According to this model, decisions result from a complex interplay of four independent streams: problems, solutions, participants, and choice opportunities. Decisions occur when these streams randomly converge in a "garbage can" where solutions are matched with problems, often without a systematic process. This model is particularly relevant in organizations characterized by high levels of ambiguity, fluid participation, and unclear goals. While it captures the randomness

and serendipity of decision-making in such environments, it also suggests that decisions can be inconsistent and haphazard.

Each of these models offers a different lens through which to understand and approach decision-making in organizations, highlighting the diversity of factors and processes that influence how decisions are made (Gigerenzer, 2020).

PERSPECTIVES OF INFORMATION SYSTEM

Global Perspective

From a global perspective, Information Systems (IS) play a crucial role in integrating and standardizing operations across multinational organizations. As companies expand globally, they face the challenge of managing operations across different countries with diverse regulations, cultures, and business practices. Global IS provide a unified platform that facilitates consistent data management, communication, and operational processes. This standardization ensures that all parts of the organization adhere to common procedures and policies, enhancing coordination and efficiency. For instance, Enterprise Resource Planning (ERP) systems help integrate various functions such as finance, human resources, and supply chain management across multiple locations, ensuring consistency and control.

Cross-Cultural and Multilingual Support: Global Information Systems must accommodate cultural and linguistic diversity. They need to support multiple languages and comply with local business practices and regulatory requirements. This necessitates designing user interfaces and functionalities that are culturally sensitive and adaptable to different user needs. Furthermore, global IS should facilitate communication and collaboration among employees from various cultural backgrounds, promoting a cohesive and inclusive work environment. Tools such as internationalized software

applications and global communication platforms are essential for bridging cultural and linguistic gaps, enabling effective collaboration and knowledge sharing across borders.

Scalability and Accessibility: Global Information Systems need to be scalable and accessible to support the growth and geographic spread of multinational organizations. Scalability ensures that the system can handle increased data volumes, users, and transactions as the organization expands. Accessibility ensures that employees, partners, and customers can access the system from any location, often requiring robust cloud-based solutions and mobile accessibility. These systems must also ensure data security and compliance with international data protection laws such as the General Data Protection Regulation (GDPR) in the European Union. By providing scalable and accessible IS, organizations can effectively manage their global operations and respond swiftly to market changes.

Functional Perspective

Support for Business Functions: From a functional perspective, Information Systems are designed to support specific business functions such as marketing, finance, human resources, and operations. Each function requires tailored IS solutions to meet its unique needs. For example, Customer Relationship Management (CRM) systems support marketing and sales by managing customer data, tracking interactions, and facilitating targeted marketing campaigns. Financial Information Systems (FIS) handle accounting, budgeting, and financial reporting, ensuring accurate and timely financial management. Human Resource Information Systems (HRIS) manage employee data, payroll, recruitment, and performance evaluations. By providing specialized functionalities, IS enhance the efficiency and effectiveness of each business function.

Integration across Functions: Functional Information Systems are often integrated to provide a holistic view of the organization's operations. This integration enables seamless data flow and coordination across different functions, reducing silos and improving decision-making. For instance, an integrated ERP system can connect finance, supply chain, and human resources functions, providing real-time visibility into inventory levels, financial performance, and workforce availability. This holistic approach ensures that all functions are aligned with the organization's strategic goals and can respond collectively to business challenges. Integration also facilitates the automation of cross-functional processes, enhancing overall operational efficiency.

Decision Support and Analytics: Functional Information Systems provide decision support and analytics capabilities tailored to the needs of each business function. These systems collect and analyze data relevant to their specific area, providing insights that inform strategic and operational decisions. For example, a Sales Information System might analyze customer purchase patterns to identify trends and forecast demand, while a Human Resource Information System might analyze employee performance data to inform talent management strategies. By leveraging advanced analytics and business intelligence tools, functional IS enable data-driven decision-making, helping managers optimize performance and achieve business objectives.

Both global and functional perspectives highlight the critical role of Information Systems in supporting and enhancing organizational operations. The global perspective emphasizes integration, standardization, scalability, and cross-cultural support, while the functional perspective focuses on specialized support for business functions, integration across functions, and decision support capabilities. Together, these perspectives provide a comprehensive

understanding of how IS contribute to the success of modern organizations (Sklyar, Kowalkowski, Tronvoll & Sörhammar, 2019).

Technical Perspective

From a technical perspective, Information Systems (IS) are seen as an assembly of interconnected components that work together to collect, process, store, and distribute information. This perspective emphasizes the hardware, software, databases, and network infrastructure that enable the functionality of IS. Key considerations include system architecture, data management, software development, and network security. The technical view focuses on optimizing the performance, reliability, and scalability of IS to ensure they meet the technological requirements of the organization. Advances in areas such as cloud computing, big data analytics, and artificial intelligence are pivotal to enhancing the capabilities and efficiency of IS from this standpoint.

Organizational Perspective

The organizational perspective views Information Systems as integral tools that support the various functions and processes within an organization. IS are designed to enhance productivity, streamline operations, and facilitate strategic decision-making. This perspective considers how IS align with organizational goals and objectives, the role of IS in improving communication and coordination, and their impact on organizational structure and culture. IS support diverse business functions such as human resources, finance, marketing, and supply chain management, contributing to overall organizational efficiency and effectiveness. From this viewpoint, the success of IS is measured by their ability to support business strategies and improve operational outcomes.

Managerial Perspective

From a managerial perspective, Information Systems are seen as critical resources for supporting decision-making and strategic

planning. IS provide managers with timely, accurate, and relevant information necessary for making informed decisions. This perspective focuses on the use of IS for performance monitoring, reporting, and analysis. Management Information Systems (MIS), Decision Support Systems (DSS), and Executive Information Systems (EIS) are examples of IS designed to assist managers at various levels. The managerial view emphasizes the role of IS in enhancing decision quality, improving response times, and providing a competitive advantage. Effective IS management involves ensuring data quality, integrating systems with business processes, and fostering a data-driven culture within the organization.

Socio-Technical Perspective

The socio-technical perspective considers the interaction between technology and the social aspects of an organization. It emphasizes that successful IS implementation requires not only technical proficiency but also an understanding of human factors, organizational dynamics, and cultural influences. This perspective addresses issues such as user acceptance, change management, and the impact of IS on work practices and employee behavior. It advocates for a balanced approach that integrates technical solutions with organizational needs and human considerations. By focusing on both the technological and social dimensions, the socio-technical perspective aims to ensure that IS are user-friendly, culturally appropriate, and effectively integrated into the daily operations of the organization.

Economic Perspective

From an economic perspective, Information Systems are viewed as investments that contribute to the economic value of an organization. This perspective examines the cost-benefit analysis of IS implementation, including the costs of development, deployment, and maintenance versus the benefits of improved efficiency, increased productivity, and enhanced decision-making. It also

considers the return on investment (ROI) and the overall impact of IS on the organization's financial performance. The economic view highlights the importance of aligning IS investments with business goals, optimizing resource allocation, and ensuring that IS contribute to competitive advantage and market success. This perspective underscores the need for careful planning and management of IS projects to maximize their economic value.

Each of these perspectives offers unique insights into the role and impact of Information Systems in organizations, providing a comprehensive understanding of their multifaceted nature and significance (Govers & Van Amelsvoort, 2019).

BUSINESS SUPPORT SYSTEMS

Business Support Systems (BSS) are a set of integrated tools and applications designed to support the various functions and operations of a business. These systems help manage and automate business processes, enhance productivity, and improve overall efficiency. BSS typically cover areas such as customer relationship management (CRM), order processing, billing, service management, and revenue assurance. The primary purpose of BSS is to streamline business operations, ensure data accuracy, and provide critical insights that inform decision-making. By automating routine tasks and providing real-time information, BSS enable businesses to respond swiftly to market changes and customer needs (Saputra, Nugroho & Ranti, 2019, October).

Key Components and Functions of Business Support Systems

The key components of Business Support Systems include CRM systems, billing systems, order management systems, and revenue management systems. CRM systems manage customer interactions and data, facilitating better customer service and targeted marketing efforts. Billing systems handle the generation, distribution, and collection of invoices, ensuring accurate and timely billing

processes. Order management systems track orders from inception to fulfillment, coordinating between sales, inventory, and shipping. Revenue management systems monitor financial transactions and ensure revenue integrity, identifying discrepancies and optimizing pricing strategies. Together, these components help manage the customer lifecycle, from initial contact and sales to service delivery and billing.

Benefits and Challenges of Business Support Systems

The benefits of implementing Business Support Systems are manifold. They enhance operational efficiency by automating processes and reducing manual intervention, which minimizes errors and saves time. BSS provide comprehensive data analytics and reporting capabilities, offering valuable insights into customer behavior, sales trends, and financial performance. This data-driven approach supports informed decision-making and strategic planning. However, there are challenges associated with BSS implementation, such as high initial costs, the complexity of integration with existing systems, and the need for ongoing maintenance and updates. Additionally, organizations must address data security and privacy concerns to protect sensitive customer and business information. Despite these challenges, the advantages of BSS in driving business success make them a crucial investment for modern enterprises.

COMPUTER BASED INFORMATION SYSTEM (CBIS)

A Computer-Based Information System (CBIS) is an organized integration of hardware, software, data, processes, and people designed to collect, process, store, and disseminate information for specific purposes. The primary objective of a CBIS is to support decision-making, coordination, control, analysis, and visualization within an organization. The key components of a CBIS include hardware (physical devices such as computers and servers), software (applications and programs), databases (structured collections of data), networks (communication systems), and users (people who interact with the system). These components work

together to ensure that information flows efficiently and accurately throughout the organization (Sembiring, Ginting, Perangin-angin, & Surbakti, 2024).

Types and Functions of Computer-Based Information System

There are various types of Computer-Based Information Systems, each serving different organizational needs. Transaction Processing Systems (TPS) handle day-to-day business transactions, ensuring accuracy and efficiency in operations like sales, payroll, and inventory management. Management Information Systems (MIS) provide middle managers with reports and tools to aid in tactical decision-making by summarizing and analyzing operational data. Decision Support Systems (DSS) assist senior managers in making strategic decisions by offering simulations, trend analyses, and data modeling capabilities. Executive Information Systems (EIS) are designed for top executives, providing high-level summaries and key performance indicators to support strategic planning. By serving different levels and functions within an organization, these systems ensure that information is accessible and useful to the right people at the right time (Farooq, Fu, Ahmad, Zhang & Hao, 2019).

Benefits and Challenges of Computer-Based Information System

The implementation of Computer-Based Information Systems brings numerous benefits to organizations. CBIS enhances operational efficiency by automating routine tasks, reducing errors, and speeding up information processing. It supports better decision-making by providing accurate, timely, and relevant information, and improves communication and collaboration within and between departments. Additionally, CBIS enables organizations to respond more quickly to market changes and customer needs by providing real-time data and analytics. However, challenges associated with CBIS include the high costs of development and maintenance, the complexity of integrating with existing systems, and the need for continuous updates and cybersecurity measures. Ensuring that

employees are adequately trained to use CBIS effectively is also crucial for maximizing its benefits. Despite these challenges, the strategic advantages offered by CBIS make them indispensable in today's competitive business environment.

SUMMARY

Information Systems (IS) are fundamental to organizational efficiency and decision-making processes, serving as a critical backbone for operations and strategy. These systems amalgamate technology, people, and processes to gather, process, store, and disseminate information that enhances business performance. They convert raw data into meaningful insights through computational processes, aiding in effective planning by providing valuable context and foresight. In the decision-making realm, IS supply essential data and context for evaluating options and predicting outcomes. They support decision-makers with timely and relevant information through tools like Decision Support Systems (DSS), Management Information Systems (MIS), and Executive Information Systems (EIS), enabling analysis and visualization of complex data. IS also play a pivotal role on a global scale by integrating and standardizing operations across multinational organizations, addressing challenges related to diverse regulations, cultures, and business practices, and promoting cultural sensitivity and inclusivity through cross-cultural and multilingual support within global IS frameworks.

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Chapter 4

THE ROLE OF INFORMATION SYSTEMS IN EDUCATION

SHEHU, **Suleiman Abdullahi & Binta MUHAMMAD**
07033674799/08027303904
Shehusuleman78@gmail.com
Federal University Gusau,
Department of Educational Foundations
PMB-1001, Gusau-Zamfara State

Introduction

An information system is an integrated and coordinated network of components, which combine to convert data into information. Therefore, management information education systems, in one form or another, have existed in different countries for several decades. They were traditionally conceived as administrative tools to automate the generation of routine inputs-based statistics, such as enrolment and teacher counts. However, changes in the education sector have driven EMIS to become more complex. Development surged around the 1980s with the advantages of desktop computing**.** Countries like France, India, and China have compiled education statistics on students, teachers, and other aspects of educational institutions for many years. In the United States, the National Centre for Education Statistics (NCES), whose responsibility is to collect "statistics and facts as shall show the condition and progress of education" has existed in some form since 1867. In the International Conference on EMIS, held in Paris France on 11–13 April 2018, which brought together actors and stakeholders in education: national governments, nonprofit private enterprises, and international organization, participating countries were asked to detail the history and evolution

of their EMIS. In general, drivers of EMIS development reported by participating countries included:

- Technological change, such as the use of the Internet to engage stakeholders at decentralized administrative units (including schools) and to facilitate data collection and processing;
- Increased expectations from administrators, planners, and development partners concerning the availability, level of disaggregation detail, and use of data;
- Evolving national and international standards such as the monitoring requirements of the Sustainable Development Goals (SDG);
- Increased accountability to the public;
- Increased complexity of education systems, which now include the need to plan and monitor for both public and private sectors across the Early Childhood Development (ECD), Primary, Secondary, non-Formal, TVET, and Higher
- Education and Increased focus on data to assess learning to ensure students are participating in education and achieving desired outcomes, including learning and the well-being of each child.

In Paris, where the submission at the first conference was held, it was pointed out that EMIS has a very significant role to play at all levels of the educational system of any country. This is because data is essential in the new international educational agenda. Countries need data to define and operationalised goals into targets, and, more importantly, to determine what they need to do to accelerate progress towards those objectives. Data allows countries to measure the performance of their respective education system vis-à-vis national, regional, and international priorities, and to determine the relevance and effectiveness of policies and programmes (UNESCO, 2018 & World Bank, 2016).

Education management information systems (EMIS), as the main tool used by countries to collect, process, analyse, and disseminate data, are crucial to this process. EMIS, in its most basic sense, entails a school census conducted annually to collect information on pupils, teachers, facilities, finances, and other issues relating to institutions, such as schools and higher education facilities. It must be noted, however, that earlier conceptions of EMIS were primarily (perhaps exclusively) administrative systems, rather than systems that inform planning, policymaking, and monitoring and evaluation process. Therefore, EMIS should be designed according to various contexts and needs of different education systems; no one EMIS configuration will work across all education systems. These contexts and needs can only be fully captured if central educational units dialogue with stakeholders at the decentralized educational units of a given country and in line with the educational policy practice (UNESCO, 2018 & World Bank, 2016).

A successful EMIS depends on the interplay of appropriate policies, budget, human resources, organisational structure, and institutions to produce valid education data. It should empower all data users to benefit from the data and foster data-driven decision-making, transparency, and accountability. Data users can include central and local authorities, schools, teachers, parents, and the broader community, including media, researchers, and nongovernmental organisations (NGOs). Therefore, a smart system requires (1) a high degree of reliability, efficiency, and sustainability of both the structure and the system; (2) full integration of all functions of the system; (3) high security of the infrastructure, particularly when subjected to extreme and unconventional conditions; (4) continuous health and integrity monitoring; (5) damage detection and self-recovery; and (6) an intelligent operational and management system (UNESCO, 2018 & World Bank, 2016)

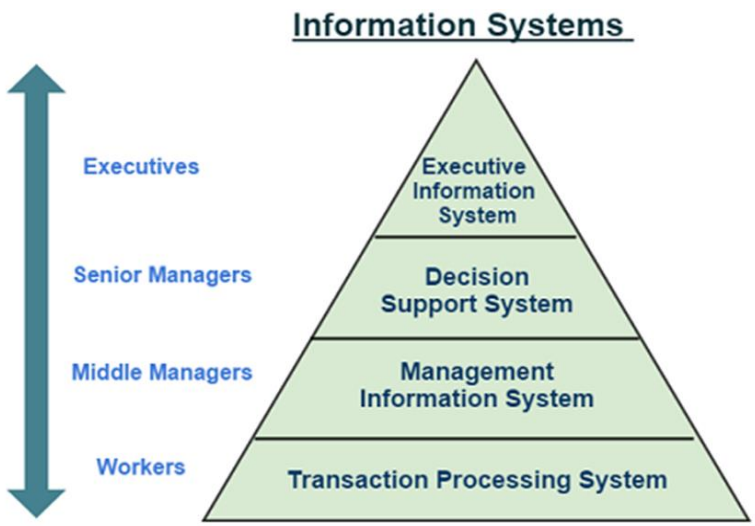

Figure 1: A Typical Example of an Information System in a formal organization

Types of Information Systems in Educational Institution

Information systems are designed according to the need of the organisations. These are categorised into many types, each having different functionality and uses. SOURCES

Major types of information system are described as follows:

1. Transaction processing system
2. Decision support system
3. Executive information system
4. Management information system
5. Enterprise resource planning and
6. Expert systems.
7. Online Analytical Processing (OLAP)

- **Transaction Processing System**

The main purpose of Transaction Processing System is to fulfill the basic needs of record keeping of an organization. (e.g. School System)

- **Decision Support System**

Decision Support System (DSS) analyses the data used in decision-making by the organisation's management. Data can be from internal or external sources. For example, if the management needs to assess the prices of a product, it may use data from external sources i.e. market prices. It helps decision-making process. It may also involve databases and spreadsheets, complex in nature, for creating models in difficult and important situations.

- **Executive Information System**

Executive Information System, also known as Executive Support System is developed for the Senior Management of the organization. It helps them to analyse the trends by viewing various reports, including summaries, and making strategic decisions for the business. These kinds of systems are easy to use and have diverse report types. The reports are prepared from large sets of data collected from various sources. For example, the management may require the data of an organizations' sales department over a specific period. The system also includes information about inventory, assets, and revenue collected or projected.

- **Management Information System**

Management Information System is also used by the management, but it differs from the Transaction Processing System (TPS) because it provides summaries of routine nature to the management. The different kinds of data, including sales, purchase, and production are consolidated in MIS. Usually, this data is collected from internal sources. Summaries are prepared from this data used by managers and decision-makers. This system can also support the marketing and

revenue departments to enhance operational efficiency and track the progress of the organization (UNESCO, 2018 & World Bank, 2016)

Education Management Information System and How It Functions

The educational management information system creates a central data repository for a school, college, or university. This subsequently enables the institution to store, access, and manage *all* important data from a single central dashboard. Authorized personnel can also access the system from anywhere in the world, using any connected device. It is essentially a productivity tool for streamlining a long list of essential admin tasks while simplifying complex data analysis and reporting. The versatility of an EMIS is such that it can be used to help an educational institution accomplish almost any immediate or long-term goal. Just a few examples of these include ***heightened profitability, improved success rates for students, better staff retention rates, ensuring prompt payments of fees, and facilitating distance learning.*** In a broader sense, an EMIS is to a school or college what an operating system is to a computer. A simplified, centralised and unified dashboard provides quick and easy access to the information, functionalities, and facilities you need (UNESCO, 2018 & World Bank, 2016).

More specifically EMIS does the following:

1. An education management information system creates a repository of all the student data collected regularly and keeps them safe.
2. The data is collected and stored in an easily searchable and retrievable way using a few keywords even after years.
3. The software generates reports from the accumulated data that can be analysed for making data-driven decisions by the stakeholders

4. The system makes use of AI technology for data learning and helps to improve the operations and functioning of the software
5. The system helps the institute conduct exams, admissions, and fees management by offering restricted access to various individuals
6. Further, the software helps in academic management for students. It enables conducting classes, uploading notes, downloading assessments, and giving important updates

Rationale for the Need of Education Management Information Systems:

An EMIS is a bespoke tool that can be customized in various ways. How an EMIS is configured and deployed will be determined primarily by the predetermined objectives of the institution. Though in all instances, an education management information system will be used to perform the same essential functions. Each of the essential functions can not only be streamlined and simplified, but in many cases, automated to free up resources and reduce the risk of human error. essential features and functionalities of an education management information system include the following:

- **Better Communication with Parents:** An EMIS can simplify the process of communicating with parents for faculty members and administrators. Instant communications and mass communications can be sent with ease, keeping parents informed about important events and the academic progress of their children.
- **Better Communication with Students:** EMIS can also aid individual or mass communication with students. This can be particularly useful when a time-critical announcement needs to be made, such as an alteration to class scheduling or a reminder about an important deadline.
- **Management of Fee Collections:** Automatic alerts can also be generated to inform administrators and accounts

managers of late or missed payments. A semi-automated payment management system can make it much easier to stay on top of fee collections, which for most institutions represent a primary source of revenues.

- **Enquiries and Admissions Management:** Most common questions and inquiries regarding admissions can be answered using automated EMIS solutions, freeing up invaluable resources to be allocated elsewhere. In addition, much of the initial admissions process can also be automated, as can tracking key data on students admitted and application patterns.
- **Examination Management:** The scheduling and communication tools provided by an effective EMIS can be useful for planning, scheduling, and sharing important information about exams. The same system can also be used to publish exam results to be accessed by students and authorised faculty members, track pass rates and create detailed reports on current, and historical student performance.
- **Student Information Dashboard:** This facility provides faculty members and parents with quick and easy access to all key information on students' academic activities. This may include things like fee payment history, attendance data, exam results, and general academic performance information. All are linked with the simplified communication tools of the platform to connect parents and students with faculty members.
- **Attendance Management:** Attendance tracking and management in its entirety can be almost fully automated with EMIS integration. Faculty members and administrators no longer need to track attendance manually, but simply consult automatically generated reports and respond to alerts where issues are detected.

- **Accommodation Management:** All aspects of accommodation management for institutions with on-campus housing can be simplified with an EMIS. This includes queries and questions from prospective students, management of available inventory, logging maintenance issues, collection of payments, and more.
- **Integrated Downloads Centre:** One of the most essential features of an EMIS, an integrated downloads centre provides learners and faculty members centralised access to all the resources and materials they need via their preferred connected device. A facility that can significantly reduce the requirement for physical study aids, and the consequences associated with lost learning materials.
- **Timetable Management:** The EMIS can be used as a central database for all timetables and schedules – concerning the institution's faculty members and its students. Anyone wishing to do so can access and/or print these timetables at any time, making it easier to plan for lessons, meetings, and functions.
- **Payroll Management:** Business owners and managers are likely to find the payroll management features of an EMIS invaluable. A comprehensive log of all essential payroll information is maintained, along with additional functionalities including requests for leave and remaining paid holiday entitlement.
- **Lesson Plans & Assignments:** Faculty members have the option of sharing assignments and lesson plans in advance with students (and their parents) while providing access to the materials needed to prepare for the lessons/assignments in question. All of which can be downloaded or printed with ease.
- **Transportation Management:** Where an educational institution also provides free or subsidized transportation, an EMIS can help. The system can be used to store, track and

manage information on things like bus routes, transportation timetables, driver information, available seats on buses, approximate arrival times, etc. (UNESCO, 2018 & World Bank, 2016)

Benefits of Education Management Information System in Educational Institutes

In this modern era, educational institutions need various technological tools to manage and run their institutions efficiently. With the technological advancements, they need to opt for a system or software that can help them connect all the operations in a single system that provide access to all the operations. An education management system is new-age software for institutions that can help them to manage all vital operations efficiently and become the backbone of modern institutions. There is a landscape for educational institutions today in which they need to set their footprints by not working on only spreadsheets, Microsoft Excel, Microsoft Word, and similar tools that make institutions slow and far away from the top technology and trends. Therefore, having an education management information system can help institutions make quicker decisions and provide systematic, simple, and efficient work, bringing complete automation in every way**.** From the above development, it is clear that Educational Management Information System in our 21st-century Educational Institutions operations is crucial and critical. That is so because teaching, learning activities, and human and materials resources in schools would be more effectively managed with the EMIS Platform. Hence, this showcases its benefits to the education sector, and it includes the following:

- **Easy Report Generation**- The system automatically generates a report in all the required formats
- **Integration with other Software-** Integrate the software with other systems for smooth workflow and operations

- **High Storage-** The software can store unlimited data of students and offer high scalability
- **Restricted Login Access-** The system gives restricted access to students, teachers, and admin as per their roles
- **AI-Based Analysis-** The system makes use of AI technology for data analysis and report generation
- **Online Attendance Management-** Institute can manage student attendance online using a biometric system and save time

Challenges of Adoption of ICT in Education and Suggested Solutions

Recently, there has been a great interest in how computers and the internet combine to improve the efficiency and effectiveness of educational practice at all levels. . The integration of information and communication technology (ICT) in teaching and learning goes a long way to providing more opportunities for teachers and students to work better in an information age. However, some challenges have been hindered the effective adoption of ICT in the classroom. These could include the following:

- Teachers desire to adopt ICT tools and resources in the classroom but encounter insufficient technical support at schools and have little access to Internet facilities
- Shortage of class time is another significant challenge that discourages teachers from adopting ICT in the classroom.
- The virtually limitless opportunities for access to information in an educational context can pose a real danger of information overload if the teachers do not have the skills to filter information for relevance, or establish a coherent organising principle.
- Both students and teachers may lack the necessary skills to access, process, and use information (Hadi & Zeinab, *2012)*
- Weakness of internet connection and internet speed in many of our schools

- High costs for a good internet connectivity
- Absence of customized computers/laptops/tablets/ smartphones that support online teaching and learning
- Many online instruments, platforms, and websites crash when an unexpectedly high number of clients connect to them.
- Unethical behavior, physical health concerns, and data privacy issues.
- Cheating via text messaging, sharing inappropriate content, and possibly Cell phones provide an additional means for cyberbullying. (Hadi & Zeinab, 2012*)*

In another submission, Eldridge, (2010) identifies the following as related challenges to ICT adoption and mobile technologies:

- **Problems with the Technology:**

Teachers, like most people, are often reluctant to change, but when the change involves technology, fear and misunderstanding can also ensue. Two specific types of challenges people face when dealing with change are technical and adaptive**.** A technical challenge is a change that involves using already existing information controlled by the people in charge. An adaptive challenge requires people to learn new ways of doing things. The only way to make this happen is to change the hearts and minds of those who need to make the change to see the need. Asking teachers to implement technology in their instruction is an adaptive challenge (Linsky & Heifetz, 2002).

- **Teacher Training:**

Most educators will agree that, as with most new initiatives, the implementation of technology requires changes, is cumbersome, and cannot be forced from the top. However, Tapscott (2009) believes teachers and other educators need to take note of the changing times and prepare to make changes in their instructional methods to meet the needs of their students. He continues by saying, "The current model of pedagogy is teacher-

focused, one-way, one size fits all. It isolates the students in the learning process." Net Geners learn more by collaborating with their teacher and others (Tapscott, 2009). Tapscott believes students will respond to new models of teaching and learning, many of which are beginning to surface today. Preparing teachers to utilise technology is an essential step towards the successful implementation of technology. Furthermore, when teachers feel comfortable with technology or that it will help them perform their jobs more effectively, they are more likely to integrate it.

Suggested Solutions to Improve in the Adoption of ICT in Education

An important element to consider in the adoption of ICT in Education is the need by the user of any technology (Teacher, Instructor, Students), meant for teaching and learning. The users need to be well informed on the "Technology Adoption Model", developed for predicting user acceptance of computer technologies and their alliance (Hu, 1999). Technology Acceptance Model (TAM) has received great respect in the information technology and information systems literature (Davis, 1989; Davis, 1989). The key purpose of TAM is to trace the impact of external variables on internal beliefs, attitudes, and intentions.

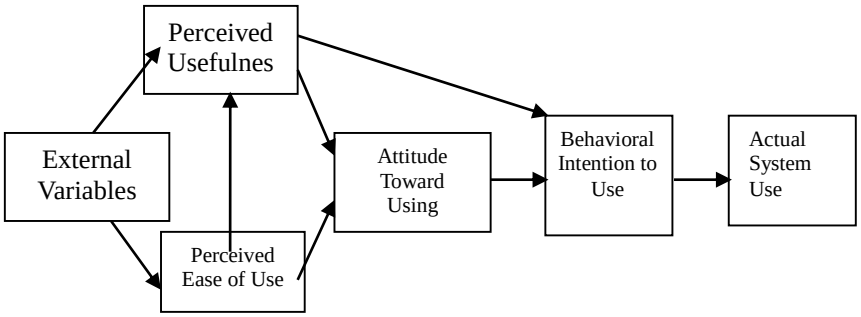

Figure 2: Technology Adoption Model

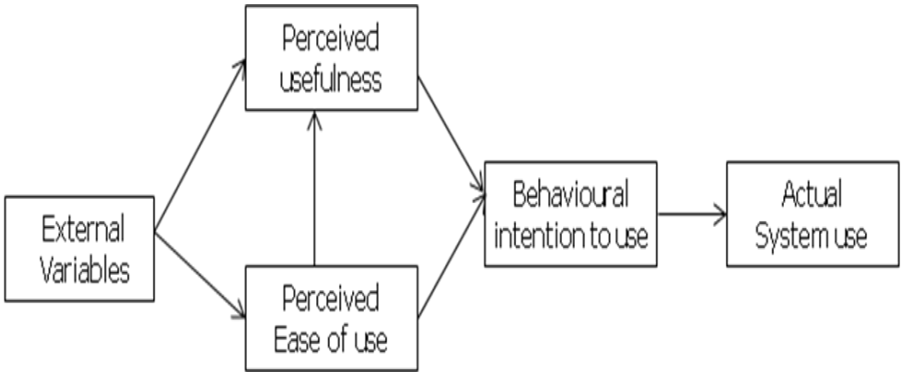

Figure 3: Technology Adoption Model
Source: Davis, 1989, p 985

The end user of modern technology in educational institutions are teachers and instructors who, to improve learning outcomes, translate curriculum from theory to practice. Therefore, to be well-trained in learning technology, all impediments to its smooth and easy use must be checked. The teacher and instructor with the required skills, competency, and knowledge adopt technology and operate it with ease and without phobia.

Some more specific challenges to resolve in adopting ICT in education include the following:

- The basic infrastructure such as electricity must be adequately provided
- ICT infrastructure must be adequately provided to schools and teachers
- Instilling a maintenance culture must be ensured in schools
- Professional development training for teachers on technological integration in education should be carried out in time to improve on skill gap
- Effective internet service supply in the school system should be prioritised for ICT facility usage
- Procurement of devices for school and teachers' use should be done by the concerned authority

Implementation of ICT in Education

The introduction of the mass media brought about information and communication Technology (ICT). The driving forces of the information revolution and the information society are the development, diffusion, and use of information and communication technologies (ICTs) in contemporary societies. The diffusion of ICTs has contributed enormously to the growth of education and economies in developed and developing nations are earnestly facilitating policy frameworks to ensure an equitable diffusion of these technologies. ICTs can, therefore, be referred to as digital-based tools for information processing, storage, dissemination, and retrieval. It also includes the different infrastructures used in these processes, their applications, and the numerous services these infrastructures render (Green, 2010).

The aim and rationale behind implementing Information and Communication Technology (ICT) in education are to make the whole process of teaching and learning easy for both the teachers and the students, and more importantly, the mainstream educational sector in this 21st –Century digitisation has driven. Therefore, the implementation of ICT in teaching and learning is not a method; rather, it is a medium in which a various methods, approaches, and pedagogical philosophies may be implemented. This statement shows that the effectiveness of ICT depends on how and why it is applied and integrated. In 1980, Taylor stated that ICT usage is classified as tutor, tool, and tutee. Tutorial programmes lead learners step-by-step through a programme such as a drill and practice. Using technology as a tool can help with other types of problems, For example, technology as a tool is frequently seen in tutorials or explanatory programmes. ICT acts as a tutee where students programme the computers to gain more understanding. A number of different ICT tools and applications may be integrated into teaching and learning. Some of these tools and applications may be designed specifically for educational purposes and others for more general

use. The choices of resources, and the way they are used, can be linked to different learning theories which may be invoked to explain or predict learning benefits from the use of ICT. From this perspective, Roblyer and Edwards believe that the use of ICT in education has evolved from two main approaches, namely directed and constructivist instructional methods. The theoretical foundations of directed instruction are based on behaviorist learning theories and information processing theory, which is a branch of cognitive psychology. The theoretical foundations of the constructivist approaches are based on the principles of learning derived from cognitive learning theory. (Hadi & Zeinab, 2012*)*

Summary

The adoption of information and communications technology in teaching and learning is considered a medium in which a variety of approaches and pedagogical philosophies may be applied. However, ICT as a teaching technology is more complicated in because it demands more specific skills from the teachers. Moreover, teachers faced some challenges and barriers that prevent them from employing and adopting ICT in the classroom or developing supporting materials through ICT. Hence, the insufficient technical supports at schools and little access to the internet and ICT prevent teachers from adopting ICT in most of our schools, even if they possess the needed skills and competency. Therefore, this needs to change, given the reality of the information age that requires all to function by using technology to accomplish things faster to meet the challenge of the 21st –Century

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Chapter 5

COMMUNICATION AND INFORMATION SYSTEMS IN EDUCATION

Manafa, Ifeyinwa F. (Ph.D)
Email: ifeyinwamanafa@gmail.com

Ohamobi, Ifunanya N. (Ph.D)
Email: kechiohamobi@gmail.com

Okafor, Patrick C. (Ph.D)
Email: patokafor2001@yahoo.com

Department of Educational Foundations
Faculty of Education.
Chukwuemeka Odumegwu Ojukwu University,
Igbariam. Anambra State, Nigeria.

INTRODUCTION

Communication is an integral part of an organization; that shows that without communication, an organisation cannot function effectively. In organisations like schools, the school manager directs, coordinates, staff, plans, and controls through communication. No action will be taken in the school without communication. In essence, school managers should possess communication and communication technologies skills to help their workers increase communication. Communication technology enhances communication anywhere and brings people closer to each other. Communication is a network of workers or people connected for better understanding. It is the cheapest and easiest asset to deal with, but it seems the most difficult. It is on this note that the researchers intend to study communication

and information systems in education and their advantages. The study focuses on the following sub-topics: definition of communication; organisational communication; benefits of communication in organisations; communication barriers; suggested solutions; communication models and theories; advantages of communication models and theories; summary; revision questions; and references.

Definition of Communication

The world today is becoming more digitalised and globalised. Globalization has made organisations anywhere in the world closer. With this, good communication is needed to connect these organisations to exchange goods and ideas. Communication touches every aspect of human endeavour as it is an instrument for interaction. It is a medium through which good relationships are established, extended, and maintained. To this end, Manafa (2018) defined communication as a process that people use to exchange messages and share feelings and ideas with another. Communication, therefore, is the means by which people in an organisation exchange information, ideas, facts, and emotions by the use of words, letters, and symbols for successful operations in the organisation. Communication can come in two different forms. It can be within yourself (intrapersonal) or with another person (interpersonal). Thus, McLean (2005) stated that intrapersonal communication is communication with one's self, which may include self-talk, acts of imagination and visualization, and even recall and memory. SkillsYouNeed (2022) defined interpersonal communication as the process by which people exchange information, feelings, and meaning through verbal and non-verbal means: Verbal means is the usage of language to send information through speaking, while non-verbal means using of body language, gestures, and facial expression to convey messages to others.

Communication in formal organisations has been very vital because of its critical role. For example, in the school setting, the main work of a school principal is to influence teaching behaviour in such a way as to improve learning situations in school, and this is through communication. Currently, 21st-century communication skill is very important for survival. Communication skill is needed to write and speak very well. It is the ability one uses when giving and receiving different kinds of information, for example – active listening, writing, speaking, confidence, friendliness, and reading (Raju & Swamy 2022).

Communication and information system focuses on information processing and communication system, using mathematical methods and computer technology as the main tool to study a variety of information processing, modern digital communication, and broadband network technologies. As a result, communication and information system is a process of facilitating communication between people with the help of technology like phones, faxes, computers, and so on. Communication and information system is valuable to any organisation because it ensures that communication takes place. There are four elements of the communication process, sender, message, channel, and receiver.

Sender: This is said to be the person that gives out the information to individuals or groups of people. That could be the originator, writer, speaker, demonstrator, or teacher.

Message: This is the information the sender passes across to an individual or a group of people. It could be verbal, non-verbal, the combination of the two, visual, or through sign.

Channel: This is the medium or means by which the message is being delivered. It could be face-to-face, by phone, radio, television, newspaper, social media, or other technology-aided facilities.

Receiver: This is the person the message is meant for. This maybe the reader, the listener, users or viewers of the message.

These elements play important roles in determining the effectiveness of communication. None of these elements can operate in isolation; therefore, for effective communication, the four elements of communication must work together.

Effective communication takes place only when the sender receives feedback from the receiver, indicating that the message is well-understood. That was emphasised by Manafa (2016), who stated that effective communication is not just giving out information, writing a memo, making telephone calls, or having a face-to-face conversation; rather, it is sending a clear message and understanding the intent of the message through feedback. Cousera (2022) defined effective communication as the process of exchanging ideas, thoughts, opinions, knowledge, and data so that the message is received and understood with clarity of purpose. Effective communication in an organisation enhances teamwork, retains employees, enhances creativity and innovation, and builds strong interpersonal relationships. Therefore, effective communication intends to send a message (verbal, non-verbal, and visual) accurately to the appropriate person, irrespective of status and personality characteristics.

For effective communication to take place, communication techniques and skills must be considered. Indeed (2021) stated that communication skills are the abilities of the sender and receiver when giving and receiving different kinds of information. There are four essential communication skills for effective communication. They are active listening, speaking, writing, and reading.

Writing: This is an act of expressing our ideas, thoughts, and views. It is done through language, which is the medium of communicating

ideas, thoughts, or feelings in writing. Writing is a way of presenting ideas or opinions in a logical and organized manner. The principal uses writing as a formal way of communicating. Most communication in written forms is there forever when kept well. In writing, the message should be concise, with simple language, short sentences, and devoid of repetition. Teachers also use writing for their lesson notes.

Speaking: It is done through face-to-face, telephone, radio, television, speech, and other media. The major advantage of speaking is potential speed and complete interchange, as questions can be asked and answered instantly. The sender is directly in contact with the receiver and receives feedback immediately. Speaking is used by the school principal and teachers most time for direction, instruction, discussion, teaching, and so on.

Active listening: One needs to listen actively to the message sent to him. Where there is active listening by the receiver, the communication becomes unambiguous. To practice this, the receiver should use his words to repeat what the sender has just said. With this, the receiver clarifies the message. When this happens, it gives the sender feedback immediately. Listening can be affected by personal bias, environmental factors, a short attention span, rehearsing a response, daydreaming, hot words, or through filtering (Akinnubi, Gbadeyan, Fashiku & Kayode 2012).

Reading: This is by proofreading, editing, and formatting written works. It checks for spelling, punctuation, sentence formation, grammar, and other errors in writing. This skill is necessary for the principal and teachers because it makes him/her avoid the use of jargon and commonly misused words like your and you're.

Organisational Communication

Communication is very important for any organisation to achieve its goals and grow professionally. It is a means by which people in an organisation exchange information regarding the operations of the enterprise. Kapur (2018) stated that organisational communication is communication that takes place within the organisation. Thus, organisational communication can be defined as the exchange of information in an organisation, such as schools, offices and government ministries, parastatals, and agencies for the benefit of the organisation and society. Principals of schools are expected to adhere to acceptable patterns of communication. Wrench and Carter (2012) noted that organisational communication consists of internal and external environments: Internal environment involves the departments and the staff of the organisation, while the external involves the vendors, competitors, customers, and stakeholders. In educational organisation, the internal environment consists of the principals, teachers, students, and the school community, while the external environment consists of the ministry of education, government agencies, parents, and the community.

The school principal or the head teacher, as the case may be, communicates messages to members within the internal and external environments. This can be upward, downward, horizontal, or diagonal. These are ways of communication in human organisations. It is basically the movement or flow of information among the superior, colleague, and the subordinate.

Upward communication: This is the type of communication that originates from the subordinates to the superior in an organisation. This type of communication might come as feedback from subordinates, a response to a query, or a request for a directive.

Downward communication: This type of communication flows from the superior to the subordinate in any human hierarchical

organization. In a school organisation, for instance, the information flows from the principal to the vice principal to the deans or heads of departments, to the teachers or other staff, then to the students. The main purpose of downward communication in any organisation is to direct, instruct, and command. Peretomode in Manafa (2016) suggested five basic purposes for using downward communication in an organisation.

They are:

(a) To provide specific task directives or job instruction
(b) To provide information about the rationale of the job
(c) To provide information about organisational policies, procedures, and practices.
(d) To provide subordinates with performance feedback
(e) To present information of an ideological nature to assist in the inculcation of a goal.

Horizontal communication: This type of communication takes place between employees on the same level, between or among peers within the same workgroup, or between groups of equivalent status across departmental boundaries. It improves departmental and member coordination, unity, and relationships. Horizontal Communication helps to posit relevant people in an organization to directly contact each other to reduce the communication burden of principals and communication inaccuracy.

Diagonal communication: This is the type of communication among or between people at different levels who have no reporting relationship (no boss-subordinate relationship). It is a kind of interaction between line and staff. For instance, principals may engage teachers and non-teaching staff in discussions on how to improve learning situations in the school.

In every organisation, there is communication among subordinates, among superiors, and between subordinates and superiors. Manafa

(2016) stated that a channel of communication is the routing pattern through which messages travel. The channel can be formal or informal. A formal channel of communication is the recognised and predetermined route through which messages can be transmitted in an organisation. Informal communication is an unofficial and unrecognized means of passing information in an organisation, commonly referred to as the grapevine. Unofficial or personal information passes verbally or unofficially thereby bypassing the normal chain of command. This type of channel of communication is often referred to as gossip or rumour.

Benefits of Organizational Communication

Communication facilitates managerial functions in an organization. Therefore, the benefits of organisational communication cannot be overemphasized. Organisational communication presents several benefits to the educational organization in the following ways:

Coordinating role of communication: Communication links people and activities towards stated goals. Secondary schools are established to achieve goals and objectives, as stated by the government. In secondary schools, we have principals, vice-principals, heads of departments, teachers, students and other staff with different work schedules. Communication assists in coordinating various activities of different staff in the school to ensure success.

Another importance of communication in the educational organisation is that the educational systems have different levels – primary, secondary, and tertiary. The head teachers, principals, provost, and vice chancellors may reasonably need free channels of communication with one another. Therefore, communication becomes a valid link for the individual within it. One school principal, for example, may find out about another school's admission process through communication.

Communication provides leadership. Communication provides a vehicle by which we can implement a plan of action. It is a means of motivating members of the organisation to carry out plans willingly. Communication in the organization enables leaders to influence the behaviour of their subordinates willingly in the organization. Leadership is therefore determined by the leader's proper and improper use of communication as a tool of persuasion, (Leigh, 2015). A leader will be able to communicate with subordinates and associates.

Communication enhances prompt detection of internal strain within the institution. Inadequate communication among the teachers tends to encourage rumours and grapevine, which can be detrimental to the school's health. Open-channel communication allows the expression of tension. School principals can manage misunderstandings and tensions among teachers, staff, and students through communication. Many student crises are traceable to the communication barriers between the school authority and students (Bell, 2014). These are preventable with communication.

Communication also gives staff the opportunity to express their feelings and serves as a way of settling conflicts, reducing tension, and giving direction to individuals. Donna, (2014) asserts that, perhaps, the most useful approach to preventing conflict fostering a supportive and participatory communication climate within the organisation. Communication is also a means to effective conflict management. A powerful tool to mitigate conflict is information exchange. A key part of developing interpersonal communication and competence involves managing conflicts encountered in the organization (Ojo, 2004).

Communication is a motivational strategy to encourage the achievement of subordinates. Motivation means an inducement, incentive, inspiration, or encouragement to induce an individual to

action (Oboegbulem, 2004). Atiya and Palwasha (2013) defined motivation as a driving force that compels an individual to take action to achieve goals. Motivation increases the productivity of employees. Staff motivation in the school is the principal's duty, and it is important because it improves the performance of both teachers and other members of staff (Mustafa and Othman, 2010). For the school principal to perform these motivational functions, there must be established channels of communication.

Interactive role: Communication provides a link between the school and its external environment. There is an exchange of information by which the principal becomes aware of the needs of the community, policies, and government regulations. Communication also helps to foster school-community and public relations. Schools are communities unto themselves, but they do not exist in isolation. School-community relation is the degree of interaction and relationship among the school, staff, and the community. A school-community relationship is a two-way symbiotic arrangement through which the school and the community.

Communication is an aid for internal control. Internal controls keep the organization on course towards profitability (Naomi, 2002). It enables the school to deal with rapidly changing economic and competitive environments and restructure for future growth. The principal's control as a solution to various potential problems requires effective communication. Effective communication gives the principal the power to control the affairs of the school by informing all the staff about their duties on time for effective delivery.

Communication facilitates change: Since an organisation is dynamic, changes must be introduced. But when it is realised that change is a must and desirable, communication is the tool to realise it. Therefore, when introducing change, if the issues involved are fully explained to

employees through communication, the full benefit of such change can be realised.

Communication enables organisations to avoid costly failures. If there is a communication breakdown in an organisation, law and order are not kept, and instructions and directions are not followed. It leads to avoidable failure in the organization (Udeze, 2005). Where there is effective communication, strikes, sabotages, lockouts, stoppages, frauds, and target blockages can be avoided (Udeze 2005).

Communication Barriers.

There are some barriers responsible for ineffective communication. They might be intrapersonal, interpersonal, organisational, or technological barriers. They are:

1. **Lack of clear channel:** This occurs when the subordinate fails to use the appropriate channel of communication. Each Communication has its appropriate channel. There are forms communications that need to be done through speaking, writing, videoconference, message, or audio conference.
2. **Faulty translation:** When the message is so ambiguous, or the language is complicated, there is a tendency that it will be giving the wrong translation.
3. **Poorly expressed messages:** Bad sentences, poor punctuation, wrong choice of words, omission, and incoherence could make a message meaningless and ineffective.
4. **Interference:** This is a major barrier to effective communication. Interruption in communication distorts, disrupts, or impedes communication exchange. Distortion occurs when the message is not well understood.
5. **Code-switching and code-mixing:** This is the use of two or more languages to communicate. Changing language during communication or mixing official with local languages

during communication is an issue of concern. It confuses the receiver most time.

6. **Lack of empathy:** The senders do not put themselves in the position of receivers, hence have no feelings of how the receiver will feel on receiving the message. One can transmit a better message if one can put oneself in the receiver's place and analyse the message from his views point.
7. **Poor listening skills:** The receiver has no formal training in listening skills**,** thereby causing communication barriers.
9. **Size of the organisation and the organisation's bureaucracy:** A large organisation like the school has too many links and bureaucratic bottlenecks that a message passes through to get to the receiver. Multiple levels of hierarchy and complexities in organisations tend to cause communication barriers.
10. **Information overload:** This is when information has more than one meaning, thereby making it difficult for the receiver to understand what exactly to be done with the information. It is all about one person charged with the task of dealing with information that exceeds his capacity to process. This might cause misinterpretation, oversight, neglect, or abandonment.
11. **Organisational Culture:** This is also a barrier to communication in an organization. An organisation without formal culture or hierarchy will have issues with passing communication from a superior to a subordinate or vice-versa
12. **Emotional problem:** This usually happens when the sender or receiver is troubled and emotionally unbalanced. This affects the reaction to receiving or sending information. This is because our emotions, at times, control our actions and reactions.
13. **Inadequate communication gadgets:** Where there are inadequate communication facilities such as computers, internet facilities, networks, fax machines, telephones,

electronic bulletin boards, and so on, communication constitutes impediments to communication in the organisation.

Communication model theories

The concept of communication was developed from some well-known and established management thought. The following are some communication theories to consider: Process Theory by Shannon and Weaver (1948), Wilbur Schramm's Communication Theory 1954 and Barrier Theory by Walter Lippmann (1922).

Public Theory of Communication (1922).

Walter Lippman (1922) was the proponent of public theory who developed the idea of propaganda, claiming that in order to conduct propaganda, there must be some barriers between the public and the event. With this separation, there is the ability of the media to manipulate events or present limited information to the public. He later noticed that the media was causing a communication barrier by altering the flow of communication by limiting the media content that was presented to the public.

Lippman's barriers to effective communication are artificial censorship, gatekeepers in the media, shrinking news holes, limitation to social context, and meager time for paying attention. Others are fuzzy language, misalignment with culture and values, history distrust, negative influencers, distraction sources or spokespeople with no credibility, unreliable media, and capture audiences. This theory believes that these barriers affect effective communication and that the best thing to do is to eliminate them for a better organisation. He also noted that barriers distort information and limit information to the people. With this, he proffered some solutions, which include – defining your audience, encoding your message effectively, choosing the proper medium to convey your message design, delivering the message so that it gets the attention

of the intended audience, identifying your social relationship with them and the use of seven C's which are clarity, credibility, content, context, continuity, Capability, and Channels. This theory will help an organisation as it will make the management identify the communication barriers and reduce them for effective communication and achievement of organisational goals.

Shannon's and Weaver's Information and Communication Theory (1948)

Claude Edward Shannon and Weaver are considered the founding fathers of Process Theory in 1948. This theory explains more about effective coding, transmission, and appropriate information in a communication system. Shannon and Weaver's communication theory exposes the problems in Information and Communication Technology (ICT) in updating information services for research. It encourages improvement in technology. This theory also believes in the communication process. It shows that many problems and challenges in different communication systems are not from the system structure but from the communication process, which is encoding, medium of transmission, decoding, and feedback. Shannon and Weaver believe that the communication process is very important for effective communication and that distortion of any of them affects the whole communication. Therefore, the communication process must be taken care of. It was asserted that the key concepts of this theory are entropy, channel, capacity, and coding

Wilbur Schramm's Communication Theory (1954)

Wilbur Schramm is a well-known communication theorist that propounded a theory on elements of communication in 1954. He believed in two-way communication, which is information passing between the sender and the receiver. He developed a communication model in his book, titled "The Process and Effects of Mass Communication." This theory posits that communication has three elements – the sources, the message, and the destination. The

message should be encoded by the source and taken to the destination through channels, where the message is received and decoded. It determines how communication between two or more people works when exchanging information and ideas. Schramm's communication model includes sender, encoder, decoder, interpreter receiver, message, feedback, medium or media of instruction, and noise. This theory noted that coding and decoding are the two essential processes of effective communication.

Wilbur Schramm's communication theory sees communicators as both sender and receiver of messages. That shows that the sender should use proper channels to deliver the message; the sender should listen attentively to encode it and give feedback to the sender to know that the message is well understood. By so doing, both the sender and receiver are active in the communication, and communication becomes effective.

Advantages of Communication Models and Theories

Communication theories are of a very big advantage to individuals and organization. The advantages are as follow.

1. It helps identify communication processes that benefit the sender and receiver for effective communication.
2. It emphasizes the need for feedback in communication; without it, communication is incomplete.
3. These theories again help to identify communication barriers that impede effective communication.
4. They proffered solutions that will help reduce communication barriers for effective communication.
5. Communication theories also provide a synthesis of system concepts for organisational communication to identify the organisational structure and how they will need effective communication to coordinate the activities of the various units to achieve organisational goals.

6. Theories also encourage upward and downward communication for the benefit of an organization.
7. They encourage good human relationships through effective communication.

Summary

Communication is the life wire of any organisation. Therefore, individuals and organisations need communication to survive. More so, the world seems connected through telecommunication with the introduction of system information technology, which communication technology activates. That emphasises one of the importance of communication. Despite that, organisations should eliminate communication barriers by utilizing the proffered solutions mentioned in this text. Communication theorists are of help to the history of communication. They brought different ideas on effective communication and mentioned solutions that will help reduce communication barriers. These theories helped in emphasizing and upholding communication today.

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Chapter 6

THEORIES AND MODELS OF INFORMATION AND COMMUNICATION TECHNOLOGY ADOPTION

Prof. Chinyere N. Alimba
Centre for Peace and Security Studies
Modibbo Adama University, Yola
chivoplc@yahoo.com

INTRODUCTION

Information and communication technology (ICT) is greatly revolutionising the world. Countries around the world are subscribing to it because the world is ICT driven. It is either you join in its adoption or you are left behind. This shows its importance and relevance in the schemes of event in societies worldwide. The adoption of ICT becomes essential because of its application in all walks of life. For countries to improve their productivity and make tangible contributions in international relations, they must be ICT compliance. There is evidence to the fact that ICT usage contributes to productivity and output growth at the firm level (Lehr and Lichtenberg, 1999; Brynjolfsson and Hitt, 2003). This will in turn heighten the performance of a country, in terms of the growth of their Gross Domestic Product (GDP) and foreign investment. Jonsson, Bergström and Butovitsch (2024) reported that

> *Advances in ICT and its impact on modern society are greatly intertwined. As a general-purpose technology, the impact of ICT has not been limited to the sector in which it has been produced, but has spread across all sectors of production and consumption, significantly improving the quality and variety of many products and services that have gone to market (p.2)*

By extension, the development and growth of ICT have drastically transformed the conventional ways of doing things in societies. ICT has become a general-purpose technology that societies cannot do without in their daily routine operations. It enhances organisational performance and paves the way for the emergence of digital economy. Erumban and de Jong (2006) posited that ICT has created a revolution by making the world seem smaller and improving potential economic growth. This is the reason why its acceptance or adoption in societies cannot be negotiated. ICT adoption involves the deliberate introduction of ICT appliances into the daily routine operations of an organisation, for the purpose of reaping its benefits. Chong et al. (2001) observed that adoption of the ICT is considered as a means to enable businesses to compete on a global scale, with improved efficiency, and closer customer and supplier relationships. The adoption of ICT will place organisations at a favourable competitive edge, improve their visibility on global scale and enhance consumers' patronage and relationship. This shows how essential information and communication technology is to the survival of societies in this modern time. Therefore, considering the relevance of ICT adoption, this paper intends to explore its theories and models.

CONCEPTUALISATION OF THEORY AND MODEL

The world is governed by a set of rules and principles that make it conductive for human and non-human cohabitation. These rules and principles guide the conduct of activities of people to avert frictions. For a better employment or utilisation of the resources endowed by nature, humanity is expected to observe the regulations controlling nature and human conducts. The avoidance of the laws of nature is a cause of most of the environmental challenges beclouding the humanity. Climate change syndrome, deforestation, drought, flooding, earthquake etc, have escalated due the activities of people, which are generally devoid of the observations of the necessary regulations of nature. For effective and efficient utilisation of ICT, there are certain theories and models developed to guide its applicability in

organisations and societies. However, before discussing these theories and models, which represent the guiding principles for its usage, it is necessary to demystify the variables, before looking at their importance.

Conceptualising theory

In the academic circle, the term theory has been conceptualised by various scholars. For instance, Bacharach (1989) defined theory as a system of constructs (concepts) and propositions (relationships between those constructs) that collectively presents a logical, systematic, and coherent explanation of a phenomenon of interest within some assumptions and boundary conditions. Theory is a statement of fact that can logically be used to clarify an event for better understanding and applicability. Similarly, Vogt, (2005) described theory as a statement or group of statements that clarify the mechanics of the world around us and frequently explains relations among phenomena. Theory intends to relieve people of the burden of understanding an event. It critically explains a phenomenon to the extent that people will have a good grasp of it for a better way of applying it. Theory, therefore, is a group of rationally arranged laws or relationships that define a discipline, and seeks to clarify a problem, describe revolutionary elements of a phenomenon (Heinen, 1985). Theories are law that should be observed, with clarity, in the investigation of a phenomenon. The essence of those laws or possibly principles is to help in providing clarity in the understanding of a situation for effective application. This makes theory as assertions clarifying, explaining, and describing real-life situations. The definition of Kerlinger and Lee (2000) was quite broad, theory was considered as a set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena. These ideas bring to fore three dimensions inherent in theory, which are micro-level, meso-level, and macro-level (Neuman, 1997).

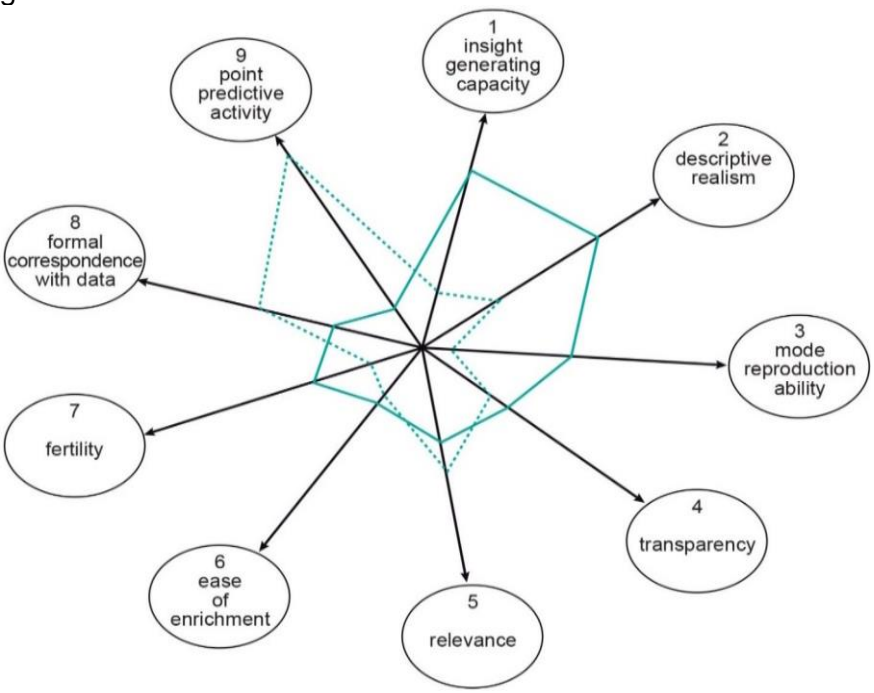
At the micro-level, theories explain relationships among individuals, while at the meso-level, theories try to explain interactions among groups at an institutional level. At the macro-level, theories seek to explain relationships at a more aggregative level, such as across gender among a particular ethnic group, or students' performance at a state or national level (Kivunja, 2018). Therefore, theories enable researchers to name what they observe, to understand and to explain relationships and to make sense of human interactions (Kivunja, 2018). The essence of theory is to ensure the cumulative of knowledge for effective usage to enhance production and the productivity of a system.

Describing model

Models exist in all fields of enquiry and professional circles. Their usage varies from one scholarly or professional sphere to another. Conceptualising a model equally varies, depending on the context. However, the word "model" derived from the Latin word "modulus", which means "measure" or "standard" (Frigg, 2022). It reappears in the 16th century in Italian as "modello" and in English as "model" (Frigg, 2022). Schichl (2004) considered a model as a simplified version of something that is real. It is worthy to stress that there are certain things that may be real, but may not necessarily be a model. The idea is that a model is used to portray reality. Wainwright and Mulligan (2013) described a model as an abstraction of reality. They stated further that abstraction represents a complex reality in the simplest way that is adequate for the purpose of the modelling. Model usage varies in their level of formality, explicitness, richness in detail, and relevance (Schichl, 2004). These properties make hypothesising model in terms of description to be burdensome and created ground for the existence of volumes of its connotations.

Steinmuller (1993) defined a model as information: on something (content, meaning); created by someone (sender); for somebody (receiver) and for some purpose (usage context). This definition raises

some salient ideas that a model has information input and information outcomes that those interested people can utilised. Therefore, a model is a way of describing or explaining the interconnectedness of ideas to portray reality. According to Stachowiak (1973), a model needs to possess three features, namely: (i) mapping feature, which is based on an original; (ii) reduction feature, reflecting a (relevant) selection of the original's properties; and (iii) pragmatic feature, describing the usable nature of a model in place of the original with respect to some purpose. These features show the relevance of a model in fostering reality. This is anchored on its purpose. Randers (1980) distinguished nine general characteristics of models, where the objective of the study determines the importance of each of the characteristics. Fig 1 illustrated the nine general characteristics of models.



Source: Randers (1980)

Randers (1980) explicated the above characteristics thus:

(i) insight-generating capacity: the model increases insight into the system and its image;
(ii) descriptive realism: system and model structure are similar;
(iii) model reproduction ability: model reproduces typical system behaviour;
(iv) transparency: the model is useable and understandable, also by non-experts;
(v) relevance: according to experts, the model provides meaningful solutions to the problem;
(vi) ease of enrichment: the model can easily be adapted;
(vii) fertility: the model stimulates generation of new ideas, new experiments, new policy;
(viii) formal correspondence with data: the model reproduces known observations accurately;
(ix) point predictive ability: the model makes good predictions.

USES OF THEORY AND MODEL

Theories and models are fundamental in the advancement of knowledge, creating the framework for guiding research and enhancing policy advocacy. Therefore, they are essential for the following reasons:

(i) Theories and models are used as framework for understanding complex phenomena

Conditions that can be explained, interpreted and clarifies are phenomena that have been clearly understood and can be significantly used to promote their optima utilisation and employment to explicate and enlighten people. Therefore, theories and models are organised body of concepts and principles intended to explain a particular phenomenon. They allow researchers to make links between the abstract and concrete; the theoretical and the empirical; thought statements and observational statements (Mohammed, Olukayode, & John (2019). The point is that theories and models

help researchers and policy makers to understand clearly the linkage between abstract and concrete variables, showed that they will aid in enhancing their applicability in real-life situation. This, perhaps, was why Suppes (1974), posited that these elements are useful in research for: (i) analogy, (ii) reorganising experiences, (iii) for recognizing complexity (iv) solving problem and (v) averting the triviality of empiricism. This is suggestive of the fact that complex situations can comprehensively be clarified through theoretical suppositions as well as modelling.

(ii) **Predicting Outcomes**

Theories and models are good archetypes for predicting outcomes. According to Frick and Thompson (2008), predictions must be based on scientific theory, its implications and data to support the theory. This idea is equally applicable to models. The relevance of theories and models are anchored on their capabilities and potencies to forecast end-result of a particular condition. This is because, in most cases, they are scientifically tested, however, when applying prove unbearable, question is posed on how to justify expending great effort and resources, only to end up with something that is not better—or possibly even worse—than what now exist? (Frick & Thompson, 2008) It will be difficult to establish the correlation between variables, explain their behaviours and peculiarities without a sound scientific theory and model. When the attributes of events are comprehended, their outcomes can easily be analysed and interpreted with the help of a theory and model. The predictive potential of these elements have come under question based on their completeness identity. Kleinberg, Liang and Mullainathan (2019) raised the question that how much of the predictable variation in the data is captured by the theory? However, they went ahead to posit that when testing a theory, it is important to ask not just whether its predictions match what we see in the data, but also about its "completeness. The idea of completeness is anchored the degree of predictable variable captured by the theory. Whether the outcome is

fully or partially predicted, a fundamental characteristic of theory and model is that they forecast outcomes, which will help to create a sense of direction for the achievement of set priorities.

(iii) **Create a sense of direction for research**

Theories and models are essential in offering guidance and direction for research endeavours. They are the foundation for scientific inquiry and researching. The formulation of hypotheses and interpretation of results are geared towards the understanding of the required theory and model. Dankasa (2015) averred that a well-crafted theory and model will support logical thoughts and helps to make sense of the reality that researchers struggle to present. These variables provide the direction for systematic evaluation of a phenomenon in order to describe reality. Spink and Heinström (2011) were of the opinion that new theories that point to new directions in the study of information science have also emerged. The direction that theory and model create for research is essential and necessary to give it meaning. When direction is lacking, researchers will find it difficult to engage and continue their studies. Cunningham (2013) stated that lack of clear direction for theory development makes the process "one of the most frustrating and arduous tasks in which a scholar engages". Theory and model will help significantly in making genuine enquiry or investigation. The insights that theory and model bring into research make it a clear-cut and distinctly unambiguous for applicability.

(iv) **Informs Practice and Decision-Making**

Theory, model, practice and decision-making can systematically be correlated. They inform practice and policy making. This can be achieved through their practical application to reality. Spurling (n.d) observed that to understand the potential for policy of theories of practice, it is necessary to take a step back and think about the relationship between theory, model, empirical research and policy per se. The application of these elements to practice and decision-

making involve critical thinking. Therefore, no matter how scientifically relevance they may be, applying them to real-life situations will depend on how they are operationalised and made pertinent to policy makers. Reflection on the issue at various levels of organisational engagements, thought formations and drawing opinions and conclusions are necessary to galvanise action. However, Hoppe and Colebatch (2016) contended that the world of policy and policymaking hardly lends itself to controlled experimentation and theory testing. This is one of the issues that makes the use of theory and model for informing practice and decision-making to problematic. Thus, the failure of practice conforming with model of theory is a weakness in the practice, not in the model (Hoppe & Colebatch, 2016). Policy and decision-making summersault are not necessarily underscored by model or theory, but their wrong applications, due to poor understanding of these variables can adversely impact on practice and decision-making process. Theories and models are essential in guiding professional and policy-makers to make informed decisions that will impact on the people.

(v) **Foster Innovation, creativity and Progress**

Theories and models can stimulate new ideas and constructs that help in solving organizational problems. They inspire innovation and creativity, which provide ground for the achievement of progress. This becomes imminent because they create room for the development of conceptual images that challenge existing norms by generating alternative solutions to issues. Vandervert, Schimpf and Liu (2007) developed a preliminary theory of how creativity and innovation occur through the collaboration of working memory and the cognitive functions of the cerebellum. The authors revealed that working memory, the seat of creativity and innovation, helps acquire new knowledge that aids in problem solving. These insightful statements are revelation that theories and models make significant contributions to the inspiration of innovation and creativity in people. Through

theories and models, knowledge are created which will in turn foster invention and advancement in societies. Although, there are scholars, who believe that creativity and innovation are innate in people (Knapp, 2003; Henderson & Dweck, 1990 and Dweck, 1999).). This does not signify that they cannot be acquired. Taylor (1988) considered creativity as a capacity or trait, inherited or acquired, implying a more or less unique ability to apprehend new ideas and insights. The reality is that creativity can be inherited as well as acquired. The acquisition paradigm substantially gives the impression that theories and model can play considerable roles in fostering creativity and innovation to engender progress in a place.

(vi) **Organisation of knowledge**

Theories and models are useful template that aid in the classification and organisation of knowledge. They make complex information to be easily digested and understood for optimal utilisation. This is the reason why theories and models are considered as a body of knowledge that create direction. According to Hjørland (2013), any ontological theory commits us to accept and classify a number of phenomena in a more or less specific way. Theory and model help to organise knowledge in such a manner that it will be used by people for the advancement of the course of humanity. By implication, knowledge organisation has to consider different theories/views and their foundations (Hjørland, 2013). Going by the foregoing assertion, theories promote knowledge as well as models and the usefulness of knowledge is centered on how it can be classified and organised to make sense and meaning out of it. This, perhaps, was the reason Peng et al. (2021) opined that for any conversion of knowledge to be valuable, knowledge must be carried out on the basis of the prior common knowledge among individuals, which is the prerequisite condition of theory. Theories and models are the nerve and nucleus of knowledge generation, and the effective use of knowledge to attain progress is consequent on how it can be

categorised, ordered and organised as predicted by existing model and theory.

INFORMATION AND COMMUNICATION TECHNOLOGY ADOPTION

There is no specific description of ICT. This is because it is a wide-ranging subject that is progressively transforming people and societies. The dynamic nature of ICT makes its description is disproportionately bulky in the literature. For instance, Ritchie and Brindley (2005) defined ICT as "the array of primarily digital technologies designed to collect, organise, store, process and communicate information within and outside an organisation. Similarly, Tinio (2003) referred to ICT as a "diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information. These technologies include computers, the Internet, broadcasting technologies (radio and television), and telephony (Tinio, 2003).

These definitions critically revealed that ICT has become an integral component part of societal development equation. This is because they have to do with the processing of information and transforming into consumable good that can be used by people for the advancement of their domains. Thus, ICT are rapidly changing global production, work and business methods and trade and consumption patterns in and between enterprises and consumers (Alam & Noor, 2009). As a resource, ICT have massive advantages that will make its users to have comparative edge over those not using it. For organisations to be logically positioned for effective operations and to efficiently attend to their teeming customers, subscription to Information and communication technology is only necessary, it is compulsory to use the right gadgets and appliances for services to be delivered as expected to meet the needs and demands of users. Alberto and Fernando (2007) posited that the use of ICT can improve business competitiveness with internet providing numerous

opportunities for organisations to compete equally with large corporations.

The importance and relevance of ICT in this modern world have gone beyond the boundaries of advanced nations. Developed and developing nations of the world are tremendously subscribing ICT in their operations, based on their capacities and capabilities. Therefore, the adoption of ICT has gained considerable momentum in this era of globalisation, because of their associated benefits. Teimoornia et al. (2011) observed that with the rapid development of modern information technology, computer and networking applications have been widely used in various fields, gradually changing people's work, study and life. The point is that Information and communication technology are currently the backbone for stimulating development and growth in societies. ICT adoption is basically its acceptance by people, organisations and societies around the world. Ross and Vitale (2000) defined ICT adoption as ICT design, implementation, stabilization, and continuous improvement. This definition is a reflection of the fact that ICT adoption embraces the whole spectrum of activities from the period when end-users justify the need for adopting ICT until the period when they experience the full potential of ICT and derive benefits from them (Ziemba, 2020). Therefore, optimal application and integration of ICT in organisations and societies requires that it is sustained to make meaningful contributions to the activities of the end-users.

Determinants of ICT Adoption

Several factors influence the adoption and diffusion of ICT in organisations and societies. These factors are a function of political, social, cultural, economic and environmental issues playing out in a given place. The adoption of ICT can provide organisations with a range of benefits, allowing them to increase their efficiency, reduce costs, improve productivity, enhance connectivity with vendors and

customers, and gain a competitive edge over competitors, hence creating value for all the stakeholders (Qalati et al., 2021). The importance of employing ICT in daily routine exercises cannot be ignored in scheme of affair of people in this period of globalization. Its necessity is based on the veracity that it promotes increased production of outputs, speed up the rate of operation, enhances productivity, encourage efficiency in resources usage and encourage sustainability. Thus, communication technology has taken over of the centre stage of the activities of societies. The factors motivating its adoption are access to electricity is an important determinant of ICT adoption in low and lower middle income developing countries (Farooqi *et al,* 2020). Also, ICT imports and government effectiveness are among the significant determinants of ICT adoption in low, upper middle and high income developing countries (Farooqi *et al*, 2020). Equally, other factors that can influence ICT adoption were its perceived usefulness and its perceived ease of use, economic factors, outside influences from suppliers, customers and competitors (Manueli, Latu & Koh, 2007). The perception that ICT can easily be learnt and mastered by people without much stress will motivate people to subscribe to it. Kumar; Goel, Joshi and Johri (2024) were of the opinion that perceived usefulness and social influence emerged as the dominating factors influencing ICT adoption decision. The usefulness of ICT has prioritise it as a major significant device of the moment worldwide.Thus, the adoption of ICT has become a strategic need for organisational sustainability and competitiveness (Kumar et al., 2023). In all ramifications, the adoption of ICT has become a critical issue for the growth and development of organisations and societies.

Approaches to ICT Adoption

There are several theories and models that significantly account for the need for adoption of ICT. There are three major approaches that underscore the adoption of ICT that can be decoded from these

theories and models. They are: adoption approach, domestication approach and diffusion approach (Pedersen, 2003).

The Adoption Approach

Carr (1999) described technology adoption as the stage of selecting a technology for use by an individual or an organisation. Similarly, Samaradiwakara and Gunawardena (2014) observed Technology adoption is people's desire to utilize technology to their advantage. Thus, the adoption approach embraces the whole spectrum of activities from the period when people justify the need for adopting ICT until the period when they experience the full potential of ICT and derive benefits from them (Ziemba, 2020). The adoption approach is centred on the acceptability, proper incorporation and optimal employment of ICT in organisations for effective and efficient service delivery and to enhance productivity. ICT adoption is not related to the aspects of technology alone. It is a complex process involving user attitude and personality, social influence, trust, and other facilitating conditions that impact overall mass technology diffusion and user adoption (Mirthinti,2023). The three widely used models which tend to illustrate this approach are the Technology Acceptance Model (TAM), the Theory of Reasoned Action (TRA), and the extension of TRA into a Theory of Planned Behaviour (TPB) (Pedersen, 2003). These theories focus on the ways people see ICT, the acceptance potentials, how it can be integrated into a system and its hypothetical usage capability.

The Domestication Approach

The domestication approach focuses on the process in which technology becomes an integral part of everyday habits (Manueli, Latu & Koh, 2007) of an organisation. The approach was initially developed to help understand the adoption and use of new media technologies by households (Hirsch & Silverstone, 1992).). However, it evolved into a broader idea about the understanding of ICT and the creativity and innovation associated to its process. Domestication

approach, essentially, is about giving technology a place in everyday life, and is about the practical, temporal, spatial place, but most importantly, it underlines how this is mixed with the cultural as an expression of lifestyles and values (Hynes & Richardson, 2009).

The domestication of ICTs can be classified into four phases, namely, appropriation, objectification, incorporation, and conversion (Haddon, 2006; Silverstone & Hirsch, 2003). Appropriation stage is the transition of media technology from the commodity world in the public domain to the private domain and into the daily life of users (Haddon, 2017; Silverstone, 1993). The objectification stage concerns the active participation of users in defining technology as a space for social self-creation (Silverstone & Hirsch, 2003). The incorporation phase focuses on how people use technology and how they schedule such use in their routine and time structures. The phases of objectification and incorporation jointly address two intertwined dimensions of everyday life, namely, space and time (Matassi et al., 2019). Thus, domestication approach provides a socio-cultural perspective toward the relationship among media usage, technology, and social relationships (Cao, Daia & Liub,2023).

The Diffusion Approach

Diffusion approach explains rate at which new ideas and technology spread in a population. According to Kreps (2017), diffusion approach concerns with the spread of an innovation through a population and researchers in diffusion method have developed analytical models for explaining and forecasting the dynamics of diffusion of an innovation (an idea, practice, or object perceived as new by an individual) in a socio-technical system. The diffusion process create room for active creation and sharing of relevant information about key innovations among people to promote mutual understanding, demand for the innovations, and strategies for adopting and implementing the innovations (Kreps, 2017). Thus, there are different adopters that might be interested in a new

innovation at different times. Rogers (1962) suggested that adopters of innovations can be categorised as innovators, early adopters, early majority, late majority and laggards. The process of adoption of each of the adopter varies, depending significantly on existing factors in their social systems

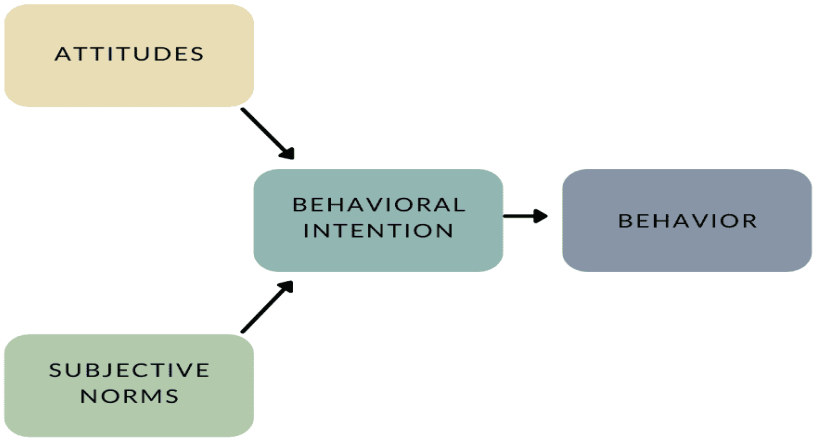
TECHNOLOGY AND COMMUNTICATION ADOPTION THEORIES AND MODELS

There are different theories and models on ICT adoption. They are developed to guide the different categories of ICT users. Some of these theories and models were discussed at this point for better understanding of their perspectives.

(i) Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) was propounded by Martin Fishbein and Icek Ajzenin in 1967. The theory is a psychological or cognitive theory that intends to explain the relationship between behaviours and attitudes in relation to human action. The proponents contended that attitude, subjective norms and perceived behaviour control all contribute to intention, which lead to some extent to behaviour. The point is that a given behaviour can be predicted by intentions (i.e., motivations) to engage in that behaviour. Behaviour-specific attitudes (i.e., evaluations or appraisals) and subjective norms (i.e., perceived pressure to engage in behaviour from significant others) determine intentions (Thompson, et al, 2012). The theory was later enlarged in their book titled *Belief, attitude, intention, and behaviour, published in 1975.*They indicated that in attitude research, behavioural intentions to perform specific behavioural acts can best be predicted by considering the attitudes as well as normative beliefs toward these acts (Ajzen & Fishbein, 1969)**.** The Theory of Reasoned Action has four main elements: Belief, Attitude, Subjective Norms, and Intention. The TRA showed that behaviour is predicted by an

individual's intention to engage in a given behaviour. Intention, in turn, is predicted by two factors, the individual's attitude towards the outcome of the behaviour and by the opinions of the person's social environment, which is called the subjective norm (Fishbein & Ajzen, 1975). Fig 2 illustrated the basic component parts of TRA



Source: Fishbein and Ajzen (1975)

The fundamental assumption that underscores the theory is that the basic elements (attitude, intention and subjective norms) are geared towards predicting human behaviour. Therefore, the primary purpose of TRA is to understand an individual's voluntary behaviour by examining the underlying basic motivation to perform an action (Willa, 2011). According to Nickerson (2023), the key take away from the theory are:

(i) the theory of reasoned action is a mathematical model that allows scientists to predict behavioural intentions as a function of attitudes and subjective norms.

(ii) The theory of reasoned action was first proposed by psychologists Martin Fishbein and Icek Ajzen as an

improvement of the information integration theory, another model of human behaviour.

(iii) They believed that attitude, subjective norms, and perceived behaviour control all contribute to intention, which leads to some extent to behaviour. The behavioural, normative, and control beliefs underlying these are influenced by external variables such as demographics and personality.

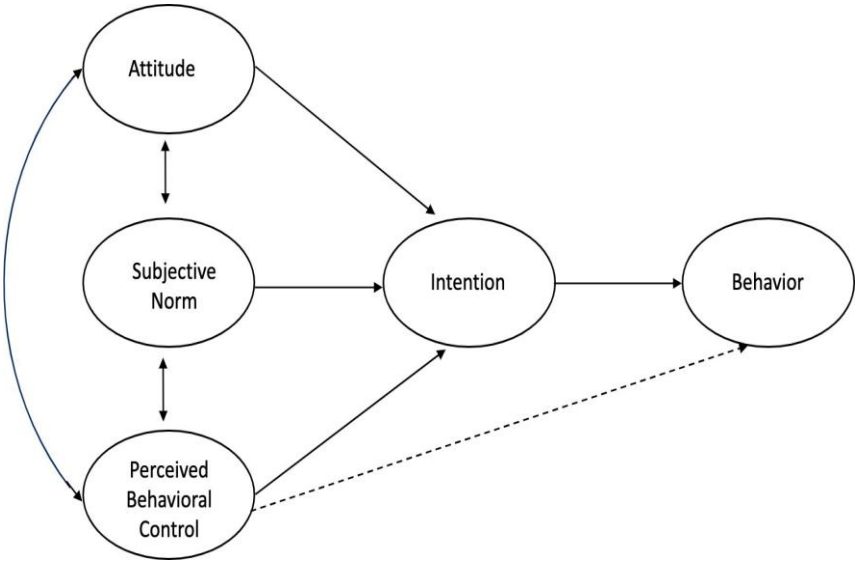
(iv) Another improvement that Fishbein and Ajzen (1975) made to the theory of reasoned action is the inclusion of two new elements in predicting behavioural intent: attitude and the expectations of other people.

Despite the criticisms leveled against this theory, it has succeeded to stand the test of time and has been applied to different fields of endeavour such as health, sociology, Mathematics, information and communication technology etc. On its application to Information ICT, it is imperative to stress that the theory is appropriate in explaining users'intention to use a particular type of technology. AL-Majali (2011) pointed out that through TRA, behavioural intention is determined by the user's intention to accept, use or adopt one or more of the IT fields. Buabeng-Andoh (2018) observed that over the years, TRA has been used as a theoretical framework to study human behaviours related to the use of information and communication technology. Attitude and subjective norm have been found to be the most important determinants of the intention to use technology (Yuen and Ma, 2008). Therefore, the idea to adopt a particular ICT will be guided by the belief, attitude and intention of a person; these will elicit behaviour which will in turn determine the outcome of the behaviour. Thus, TRA can be used to predict the pattern of human behaviour in making critical decision on the adoption of a new idea or information technology.

(ii) Theory of Planned Behaviour (TPB)

The theory of planned behaviour is an extension of the Theory of Reasoned Action. It was developed to forestall the level of criticisms associated with TRA. TPB is a cognitive theory that was developed by Icek Ajzenin 1985. The theory revealed that perceived behavioural control, together with behavioural intention, can directly to predict behavioural achievement. This idea stems from the fact that behaviours are inspired by intentions, which are influence by three major factors namely: attitudes, subjective norms and perceived behavioural control.

Fig.3: **Theory of Planned Behaviour (TPB)**



Source: Archie, et al (2022)

Fig 3 revealed the manner in which attitude, subjective norm and perceived behavioural control reinforce intention and create a pathway for which behavioural action to be elicited. Archie, et al (2022) asserted that the theory of planned behaviour assumes that behaviour is rational and proposes that behavioural intention directly

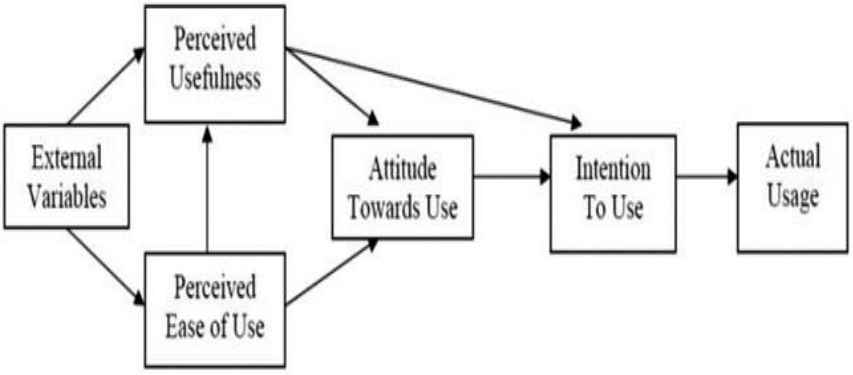
influences behaviour. Behavioural intent is affected by three constructs: attitude, subjective norm, and perceived behavioural control. To them, attitude is conceptualised as a person's favorable or unfavorable perception of behaviour, while subjective norm is conceptualized as an individual's perceptions of their peers' approval or disapproval of a behaviour. They went ahead to define perceived behavioural control as an individual's perception of their ability to perform a behaviour and that they can control their behaviour. Therefore, for behavioural intention to translate to actual behaviour; an individual need to have the ability to perform a behaviour (Archie, et al, 2022). Since the introduction of theory 39 years ago, it has, by any objective measure, become one of the most frequently cited and influential models for the prediction of human social behaviour (Ajzen, 2011).The TPB is well suited to explain its usage in the phenomenon of ICT. The adoption of ICT or its diffusion in an organisation is a function of the attitudes, subjective norms and perceived behavioural control, which will reinforce intention and thereby predicting behavioural action. This will immediately motivate the acquisition of the technology. A study conducted by Salleh and Albion (2004) on the application of TPB on ICT showed that teachers' attitudes towards the use of ICT and subjective norms significantly predict their intentions and that intentions significantly predict behaviour. The authors stated further that the TPB model meets most of the "goodness of fit" indices and found to be an acceptable fit to the data. It predicted 17% of the variance in teachers' intentions to use ICT and 24% of the variance in actual usage (Salleh & Albion (2004). Therefore, the understanding of the attitudes of people and their expectations to adopt a particular line of behaviour, based on existing positive subjective norms will provoke intention that will functionally put the behaviour into action.

The relevance of TPB in the use ICT is critical to the extent that the attitude to engage in ICT will be influenced by intention to adopt it and when the right social norm is activated, then the behavioural

expectation will be positive. Siragusa and Dixon (2009) revealed the usefulness of the application of the Theory of Planned Behaviour for providing insights into the attitudes of undergraduate students to engage in intentional use of ICT-based learning. The study concluded that the relationships between students' attitudes towards ICT, their intentions to use ICT in their future careers and their actual engagement will most likely reveal valuable insights into the design and implementation of ICT interaction for learning (Siragusa & Dixon, 2009). This is an insight that the theory of theory of Planned Behaviour (TPB) is applicable in ICT adoption or in the process of diffusion for positive outcomes. The development of positive attitude towards the use of ICT and the pressure of the subjective norm seems optimistic. On this basis, a sincere intention will be activated, which will elicit positive behavioural outcomes.

(iii) Technology Acceptance Model (TAM)

Technology Acceptance Model is one of the most widely used theory to explores the behavioural orientations of individuals concerning the recognition, approval and acceptance of information systems. It explains individual's behavioural acceptability or rejection of information technology or information system. TAM was developed by Fred Davis in 1986. The theory is based on the thesis that attitudes towards technology are shaped by two key factors: perceived usefulness and perceived ease of use (Davis, 1986). Perceived usefulness refers to the extent to which people believe that using a technology will enhance their performance or help them to achieve their goals, while perceived ease of use refers to the degree to which we believe that using a technology will be effortless and straightforward(Davis,1989). Fig 4 is the modified version of Technology Acceptance Model.



Source: Davis, Bogozzi and Warshaw(1989)

The point is that if people develop the intuition that a technology is useful and easy to use in order to achieve their set goals, they will adopt and use it. The perceived usefulness and perceived ease of use will reinforce attitude towards the technology and intention to use it will be activated, which will provoke actual usage. The model is grounded in social psychology theory in general and the Theory of Reasoned Action (TRA) in particular (Fishbein, & Azjen, 1975). Davis (1986, 1989) introduced the constructs in the original TAM (see Figure 1) as follows: perceived usefulness (PU), perceived ease of use (PEOU), attitude, and behavioural intention to use. Among the constructs, PU and PEOU form an end-user's beliefs on a technology and therefore predict his or her attitude toward the technology, which in turn predicts its acceptance (Qingxiong, 2004).

Going by TAM, perceived usefulness and ease of use are the most important determinants of actual system usage. These two factors are influenced by external variables, which usually manifest as social factors, cultural factors and political factors (Surendran, 2012). Social factors include language, skills and facilitating conditions, while Political factors are mainly the impact of using technology in politics and political crisis (Surendran, 2012). Despite the fact that

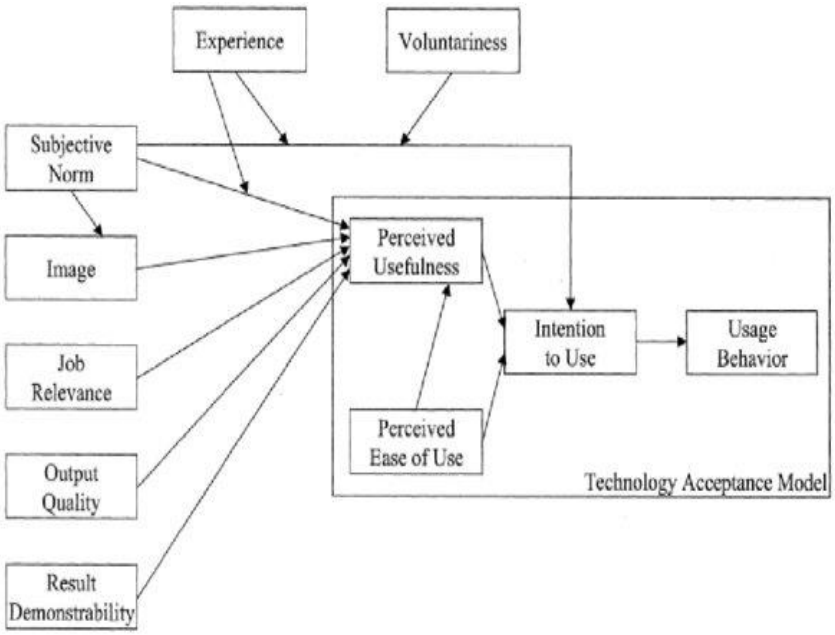
this theory can be influenced by external variables, which might be outside the end-users' prerogative to use technology, the model has succeeded to be widely employed by researchers and policy-makers to predict intentions of people to use ICT facilities. TAM and its extensions have been used in a wide range of applications in different disciplines, contexts and geographical locations, offering an important theoretical tool when it comes to predicting user behaviour (Marikyan & Papagiannidis, 2023)

(iv) Extended Theory of Acceptance Model (TAM 2)

The extended theory of acceptance model is an extension of the theory of acceptance model put forward by Davis (1986), which is used to explain and predict end-users acceptance of technology. The theory is basically focused on how perceived usefulness and perceived ease to use are potent drivers of attitude and intention, which will eventually stimulate actual usage. The extended model is referred to as the Theory of Acceptance Model 2 (TAM 2), and it was developed by Venkatesh and Davis (1996).

TAM 2 proposed that output quality increases the likelihood of a positive perception of technology, by enhancing the judgement of the technology's relevance for the job (Venkatesh & Davis, 2000). The point is that TAM 2 incorporated additional social and cognitive factors that influence how people accept and use new technologies. The proposition of TAM 2 is anchored on five additional exogenous variables and two moderators that were incorporated into its construct. The exogenous variables are subjective norm, image, job relevance, output quality, result demonstrability, experience and voluntariness. The impacts of subjective norm, voluntariness, and image are essentially enormous. Thus, the relationship among the three constructs is an important factor that affects user acceptance or rejection of an innovative system (Mei-Ying, et al, 2011). Fig 5 clearly showed the variables which are added to make the theory more robust and valuable for use.

Fig. 6 TAM2 model



Source: Venkatesh and Davis (2000).

Subjective norm is considered as a person's perception that most people who are important to him think he should or should not perform the behaviour in question (Venkatesh & Davis, 2000). Subjective norm potentially predicts perceived usefulness frankly, especially when the use of technology is made mandatory in a system. Moore and Benbasat (1991) defined image as the degree to which use of an innovation is perceived to enhance one's status in one's social system. When an individual form the habit of using a particular system that means that it functionally impacts on the person's image, which will be considered as perceived usefulness to the person. Job relevance mirrors the extent to which technology is relevant to the job of an individual. Consequently, the more significance the technology is to the task of a person, implies that the higher is the perceived usefulness.

The output quality is the degree to which an individual believes that the system performs his or her job tasks well (Venkatesh & Davis, 2000). It is imperative to stress that the effect of job relevance on perceived usefulness is moderated by output quality (Venkatesh & Davis, 2000). When this happens, the effect of output quality on the individual's task is perceived usefulness. Therefore, TAM 2 revealed that output quality increases the likelihood of a positive perception of technology, by enhancing the judgement of the technology's relevance for the job (Venkatesh & Davis, 2000).Result demonstrability is defined as the "tangibility of the results of using the innovation" (Moore & Benbasat, 1991) The inclusion of this construct in the model was based on the argument that advanced technology might not be accepted, if a user fails to embrace the benefits of technology use (Venkatesh & Davis, 2000). In the construct, experience is the passage of time from the initial use of a technology by an individual. It is a determinant of behaviour of end-users of technology. Arndt and Peterson (2018) posited that experience and perceived ease of use have a positive effect on perceived usefulness.

The direct and indirect effects of subjective norms on intention to use were considered to be moderated by experience, while voluntariness moderated only the direct effect on intention (Venkatesh & Davis, 2000). Thus, experience based on the past and the level of complexity of a system will help manifest attitudes and intentions in its use (Andika, Masudin & Zulfikarijah, 2022). This shows the difference between a much-of-experience person and an inexperienced person. Inexperience will negatively impact attitude and jeopardise the intention to use a technology, while experience will produce positive impacts on perceived usefulness. Voluntariness signified whether the use of technology should be perceived as mandatory or voluntary. Marikyan and Papagiannidis (2023) asserted that encompassing both social influence factors (i.e. subjective norm, use voluntariness and image) and cognitive factors

(i.e. evaluation of job relevance, result demonstrability, output quality and perceived ease of use), then, the TAM extension provided a detailed account of the key determinants of judgement about technology usefulness (Venkatesh & Davis, 2000), which provided the fact that technology should be made mandatory based on its usefulness in societies.

There are two moderating elements in TAM 2, namely: social influence and cognitive instrumental processes. These constructs are made up of different variables that can produce positive or negative impact on the use of technology. For instance, social influence has to do with external pressures, social expectations and prestige associated with technology use. The cognitive instrumental processes reflect how individuals evaluate the system's utility in their specific job context. These include relevance to their tasks, the quality of outputs, the observability of results, and the perceived ease of use. Equally, cognitive factors, such as how relevant and useful the technology is for the job, determine how individuals perceive the usefulness of the technology.

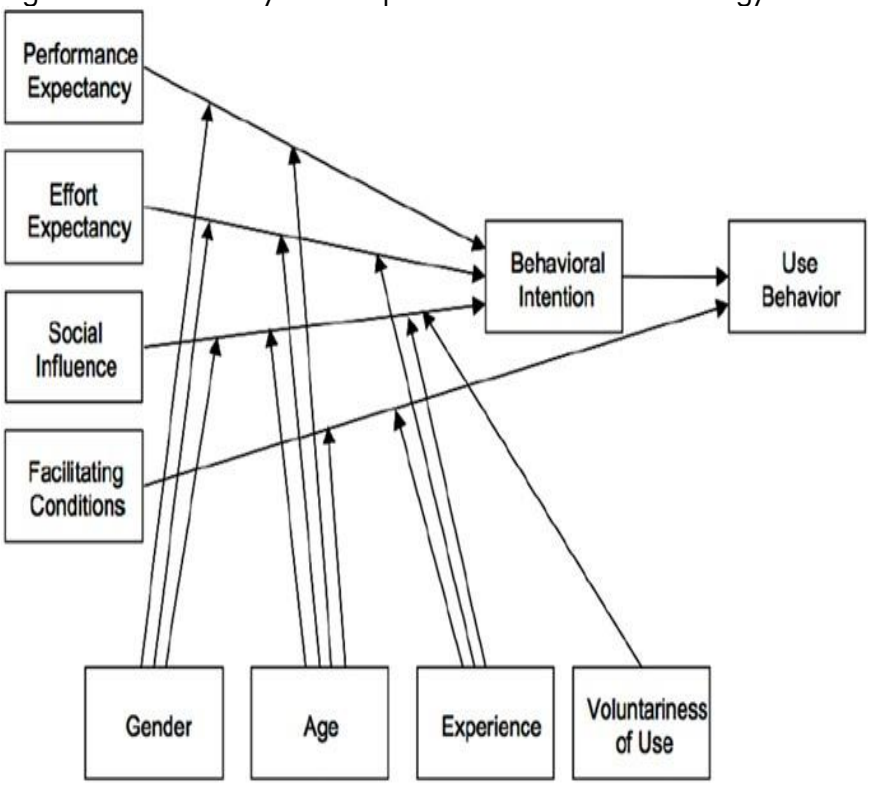
(v) Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) is a theoretical model developed to explain the factors that underpin the reasons why people accept and make use of technology. The theory was advanced by developed Venkatesh; Morris, Davis, and Davis in 2003 as a holistic structure that encompasses other theories to explain the reason why people accept and use technology. Since the development of the theory, it has been significantly used to determine the factors that influence the acceptance and usage of technology. According to Venkatesh, Thong and Xu (2012), considering the variance of information communication technologies and the advances in the sector, a number of scholars extended UTAUT to adapt it to the context or improve its predictive power. The

utility of UTAUT has been extended beyond the sphere of communication technology to other areas of human endeavours by scholars and policy makers. This is become of its precision and value, based on the combination of various theories to develop it. Therefore, to come up with the theory, eight other models of technology acceptance were integrated together, which are:

(i) Theory of Reasoned Action (TRA)
(ii) Technology Acceptance Model (TAM)
(iii) Motivational Model (MM)
(iv) Theory of Planned Behavior (TPB)
(v) Combination of Technology Acceptance Model and Theory of Planned Behaviour (C-TAM-TPB)
(vi) Model of PC Utilisation (MPCU)
(vii) Diffusion of Innovations Theory (DOI)
(viii) Social Cognitive Theory (SCT)

Fig. 6: Unified Theory of Acceptance and Use of Technology



Source: Venkatesh; Morris, Davis, and Davis(2003)

Fig. 7 revealed that the model houses four basic constructs that influence user acceptance and usage of technology. They are:

(i) **Performance Expectancy**

This is the degree to which an individual believes that using the system will help him or her to attain gains in job performance (Venkatesh et al., 2003). It is the strongest predictor of use intention and is significant in both voluntary and mandatory settings (Venkatesh, Thong & Xu, 2016)

(ii) **Effort Expectancy**

This is defined as the degree of ease associated with the use of the system (Venkatesh et al., 2003). Effort Expectancy is constructed from perceived ease of use and complexity driven from TAM, MPCU, IDT, which share a similarity in definitions and scales (Marikyan & Papagiannidis, 2023). The construct can produce significant and non-significant outcome in technology usage.

(iii) **Social Influence**

This is defined as the degree to which an individual perceives that important others believe he or she should use the new system (Venkatesh et al., 2003). The effect of social influence is significant when the use of technology is mandated (Venkatesh et al., 2003). When technology is made mandatory, individuals might use technology due to compliance requirement, but not for personal preferences (Venkatesh & Davis, 2000). This refers to the degree to which an individual perceives that important others believe they should use the technology. It aligns with concepts like subjective norms in the Theory of Planned Behavior (TPB).

(iv) **Facilitating Conditions**

This is defined as the degree to which an individual believes that an organisation's and technical infrastructure exists to support the use of the system (Venkatesh et al., 2003). Facilitating conditions have a direct positive effect on intention to use, but after initial use, the effect becomes nonsignificant (Marikyan & Papagiannidis, 2023). Therefore, the model proposes that facilitating conditions have a direct significant effect on use behaviour (Venkatesh et al., 2003).

As can be seen from fig. 7, the theory included some moderating variables which can affect the strength of these relationships. The moderating variables are: gender, age, experience and voluntariness

of use. These variables help to determine how strong the four major factors can affect behavioural intention and technology usage. The UTAUT theory has been extensively used in the studies of information systems, technology adoption, and organizational research. It has been applied in various sectors such as healthcare, education, and business to predict technology adoption behaviours.

(vi) Innovation Diffusion Theory (IDT)

This theory was developed by American communication theorist and sociologist at the University of New Mexico, named Everett Rogers, in his book titled *Diffusion of Innovations* published in 1962. Rogers (1962) pointed out that diffusion is the process by which an innovation is communicated through certain channels over time among the participants in a social system. Thus, the theory explains how innovations in the forms of new ideas, technologies and products are diffused into a given population or a social system. According to Rogers (1995), the innovation diffusion model is the process by which a new idea, concept or technology has been introduced throughout a social system over a period of time. The theory has become a foundational structure for explaining the dynamics of technological and social change, especially in fields of communication, marketing and organisational development. The major elements inherent in the theory are

(i) *Innovation*: This has to do with the introduction of new ideas, technologies or products.This innovative articles should be able to provide some perceived benefit or advantage over existing alternatives to encourage adoption.

(ii) *Communication Channels*: This is the medium through innovations are communicated to potential adopters for their diffusion into a social system. Traditional and modern measures of information conveyance, depending on location, can be employed to create the needed awareness about the idea. For instance, social

media can serve as well as local methods as channels for spreading a product for people to be aware about its existence in a place.

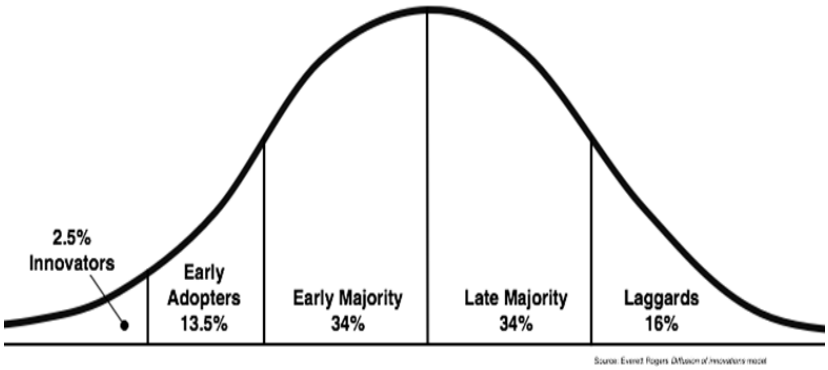
(iii) *Time*: Time influences how quickly an innovation is adopted or spread. The adoption process generally follows a pattern, with different types of adopters coming at different times, based on how they perceive the product. Over time, the rate of adoption increases until the climax is reached, after which the innovation diffuses rapidly through the social system.

(vi) *Social System*: The structure of the social system where the innovation is being introduced is fundamental for its adoption. Cultural norms, values, relationships, and hierarchies can either facilitate or hinder the processes of adoption and diffusion. Halton, (2023) asserted that diffusion of ICT is a hypothesis outlining how new technological and other advancements spread throughout societies and cultures, from introduction to widespread adoption. This signifies how new ideas and technologies are introduced and allowed to spread in a system. The theory explains the passage of a new idea through stages of adoption by different people who participate in or begin using the new idea (Halton, 2023). The main people in the ICT diffusion approach are:

(i) **Innovators:** Those who are open to risks and the first to try new ideas
(ii) **Early adopters:** People who are interested in trying new technologies and establishing their utility in society
(iii) **Early majority:** Those who pave the way for the use of an innovation within mainstream society and are part of the general population
(iv) **Late majority:** People who follow the early majority into adopting the innovation as part of their daily life and are also part of the general population

(v) **Laggards:** People who lag behind when the general population was adopting innovative products and new ideas (Halton, 2023)

Fig 7 showed the different adopter categories with their levels of percentage.



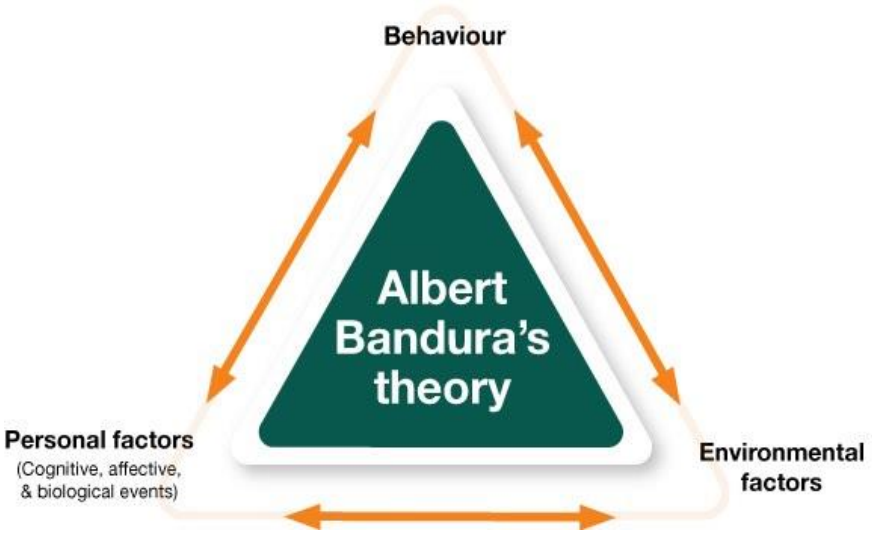
Source; Rogers (1962)

The issue is that innovators are risk bearers and they are the first set of people that will dabbled into adopting the new idea or technologies. This is the reason why they constituted 2.5%. The Early adopters are people who believe in change, and when they see it coming, it will immediately embrace it. They are comfortable adopting new ideas, and so they will become the change agents that will spread it. They represent 13.5%. The Early majority and late majority constituted the highest percentage in the diagram. The Early majority are the average people who will adopt new idea because they understand that it will improve their situation based on its innovation. They have seen the evidence of the new idea that it works before they can adopt it. Their percentage was 34%. The Late majority are people who adopt an innovative idea late, after several people have tried it and they found out that the idea is productive and inevitable, before they will decide to subscribe to it. The percentage of the late majority was equally 34%. The Laggards are conservative people, who will take their time before they can react

to an event. These people find it so difficult to embrace change, because they may not be sure whether they actually needed it. They are cautious and on the low side about a change. They are reluctant to accept a given idea. They constituted 16%. It is imperative to stress that the innovation diffusion theory offers a comprehensive framework for understanding how, why and when new ideas or technologies spread across social system. It provides valuable insights into why some innovations succeed, while others fail and helps inform strategies to promote successful adoption of a product in a domain.

(vii) Social Cognitive Theory (SCT)

Social cognitive theory is a learning theory developed by professor of psychology known as Albert Bandura. The theory was officially published in 1986 in his book titled "Social Foundations of Thought and Action: A Social Cognitive Theory". The theory stipulated that virtually all learning phenomena can occur by observing other people's behaviour and consequence of it (Bandura, 1986). Therefore, Social Cognitive Theory based on the idea that learning is affected by cognitive, behavioural, and environmental factors (Bandura, 1991). Main (2023) maintained that social cognitive theory is a powerful framework for understanding the intricate interplay between environmental factors, human behaviour, and cognitive processes. Consequently, the theory explained the process of observational learning and its influence on the development of behaviour. Fig 8 Social Cognitive Theory



The theory highlighted the mutual relationship that exists between personal factors such as cognitive, affective and biological events, environmental factors, and behaviour. It is insightful to note that observational learning is a key issue in the theory and can be described as the process of learning by watching the activities of other people and may not necessarily be a mere process of imitation. Bandura (2001) posited that the social cognitive theory emphasises that observational learning is not a simple imitative process; human beings are the agents or managers of their own behaviours (Bandura, 2001). Bandura (1986) posited that the process of observational learning was governed by four key aspects: attention, retention, reproduction, and motivation. Attention is a process in which people selectively observe and extract information from the ongoing modeled activities (Wood & Bandura, 1989). Retention involves a process of "transforming and restructuring information in the form of rules and conceptions" (p. 362) and store the information into memory. Reproduction is the act of performing the actual behaviour that was observed and motivation is concerned with propelling learners for attention, practice and retention. The theory brings to fore

the interplay of personal factors, environmental factors and behaviour. Also, self-efficacy is an important variable in the theory. It is individual's belief in their capability to perform a specific behaviour activity successfully. People with high self-efficacy are likely to be more perseverance in tackling difficulties, while those with low self-efficacy may avoid tasks they feel that is difficult. Self-efficacy is based on the individual feeling that they possess the requisite cognitive abilities, motivation, and resources to complete the task (Wood & Bandura, 1989). There are four main sources of information that create students' self-efficacy: enactive mastery experiences, vicarious (observational) experiences, social persuasions and physiological and psychological states (Bandura, 1997).

Social Cognitive Theory provides a useful framework for understanding how people learn and develop behaviours through their interactions with their environment and cognitive processes. Its emphasis on observational learning, self-efficacy, and the interplay between personal and environmental factors makes it applicable to a wide range of real-world contexts, even in the adoption of information, communication and technology. The study conducted by Compeau, Higgins and Huff (1999) on Social Cognitive Theory and individual reactions to computing technology, indicated that there is significant relationships between computer self-efficacy and outcome expectations, and between self-efficacy and affect and anxiety and use. The findings provide strong confirmation that both self-efficacy and outcome expectations impact on an individual's affective and behavioural reactions to information technology (Compeau, Higgins & Huff, 1999). Thus, the theory explains ICT self-efficacy by stressing the role of self-beliefs in one's capabilities to adopt and effectively make use technology. Therefore, In ICT usage, the level of the self-efficacy of a person will directly impacts on the decision regarding adoption of a technology.

(viii) Post Adoption Behaviour (PAB)

Post-Adoption Theory does not have a single author. It evolved from the researches of several scholars in the field of **information systems** and **technology adoption**. Much of the ground breaking works that resulted in post-adoption behaviour are conglomeration of researches that are based on **technology acceptance** and **continuance usage theories**. Some of the main researches that contributed to the evolution of PAB are the works of Venkatesh, Morris, Davis, and Davis published in 2003, which is the Unified Theory of Acceptance and Use of Technology (UTAUT) and Bhattacherjee's Information systems continuance: an expectation-confirmation model published in 2001. Thus, while Venkateshet al and Bhattacherjee are the prominent figures in the research on post adoption behaviour, but it is a cumulative body of work in the field of information systems, with no singular developer of the theory.

The UTAUT explained user intentions to use information technology, which will subsequently elicit usage behaviour. Similarly, the expectation–confirmation theory comprises four main constructs, namely expectation–confirmation, perceived usefulness, satisfaction and user continuance intention (Bhattacherjee, 2001). Post adoption stands for the continued use of a technology. However, the major issues that underlie the post-adoption behaviour are based on continued use or discontinuance. The term continuance use is defined as the extent to which users intend to continue to make use of technology. It is a positive outcome that shows the end-user is satisfied with the usage of a technology. The satisfaction will help the end-user to sustain using the technology. Bhattacherjee (2001) noted that the psychological motivations behind initial acceptance and continuance usage could be different. Therefore, the attention of Information System researchers has consequently, shifted to repeated system use and to the factors that facilitate continuance intention and continuance usage (Wu and Du 2012).

Post-adoption researchers defined Information System continuance use as "sustained use of an IT by individual users over a long-term after their initial acceptance" (Bhattacherjee and Barfar 2011). The two major factors that underscore the continuance use of information system are user satisfaction and perceived usefulness. These factors are considered as the two most salient determinant of continuance intention to use an information system (Bhattacherjee, 2001). Also, to promote the continuance usage of new ideas the need for technology and need for information were considered as predictors of continuance intention and usage (Wu, 2019). These ideas nullified the belief that IT managers cannot rely on the traditional perception–intention–usage framework because it may be deficient in explaining post-adoption behaviours (Wu, 2019). Therefore, discontinuance, which is a state where users stop using technology, is always by the corner, especially when traditional understanding of attitude formation and intention are on course. However, Margaret (2020) indicated that there is intermittent or permanent discontinuance. For intermittent discontinuers, the movement through different stages is cyclical, involving multiple stages: pre-evaluation, evaluation, preparation, discontinuance, post-action, and re-adoption (Margaret, 2020). The intermittent discontinuers are more likely to search for solutions to reduce disturbance, which implies that if disturbance is reduced there is the likely that re-adoption can equally take place. On the subject of permanent discontinuance, Individuals could go through the post-adoption cycle repeatedly until they come to permanent discontinuance (Margaret, 2020). Generally speaking, the act of discontinuance is considered as permanent abandonment of an innovation in use.

Parthasarathy (1995) developed a five-step model of discontinuance. The five stages are: (i) awareness, when adopters become aware that the current innovation is inadequate or better alternatives exist; (ii) evaluation, when adopters process the information from mass media and/or interpersonal information in order to decide whether or not

to discontinue the use of the innovation; (iii) trial, when adopters experiment and compare other innovations with the current innovation; (vi) decision, when the act of discontinuance occurs; and (v) post-decision, when discontinuers decide whether decisions made in the previous stage were optimal (Parthasarathy, 1995).

Rogers and Shoemaker (1971) suggested two reasons of discontinuance: disenchantment and replacement. Disenchantment discontinuance occurs when the benefits adopters received through the innovation (e.g., enjoyment, usefulness, and social capital) outweigh the dissatisfaction. The replacement discontinuance occurs when users "adopt a better idea that supersedes" the previous innovation (Rogers, 1995). Extant literature on information technology has come up with the idea that discontinuance cannot occur permanently because adopter can readopt an innovation may be because they realise the perceived cost of leaving an innovation (Margaret, 2020). These illustrations created a pathway for the introduction of the concept of continuance commitment, which describes the tendency to engage in consistent lines of activity based on the individual's recognition of the costs associated with discontinuing the activity (Meyer & Smith, 2000).

Factors Influencing Post-Adoption Behaviour

(i) **Social Influence**: Social norms, peer influence, and organisational adoption patterns are serious issues that underscore continue use of an innovation. How users engage with a technology after the initial adoption phase is consequent on these variables.

(ii) **Ease of Use**: If a system remains easy to use, or if users become more proficient with using it over time, continued usage is more likely to happen.

(iii) **System Quality and Performance**: A system that functions effectively, without much problem for the user, will promote sustained usage. However, systems that are

problematic over time will cause the user to engage in discontinuance,

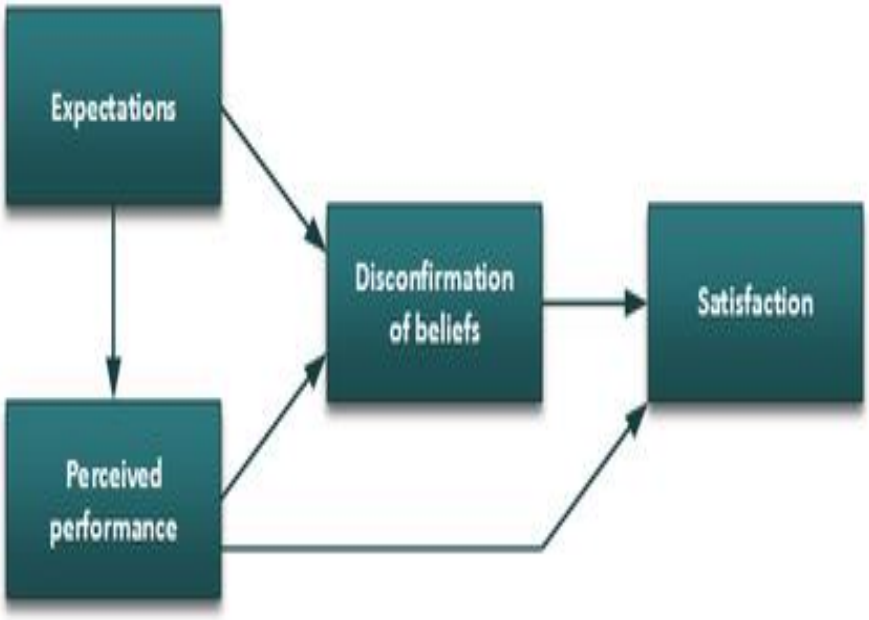
(iv) **Perceived Usefulness**: How much value users believe they derive from continued use of a technology is likely to increase levels of continued use.

(v) **Satisfaction and User Experience**: Continued satisfaction with an innovation, will result in positive interactions which is significant in post-adoption use.

Post-Adoption behaviour helps explain what happens after individuals or organisations adopt a new technology or an innovation. If the adoption results in positive social interaction and engagement with the system over time, then post adoption behaviour will be greatly activated. However, if the opposite is the result, adopter discontinuance will set in. Understanding the post-adoption behavior is crucial for sustaining technology success and ensuring user satisfaction for over a longperiod of time.

(ix) Expectation Confirmation Theory (ECT)

Expectation Confirmation Theory (ECT) is a cognitive theory that explains the post adoption satisfaction of customers. The theory is anchored on the forces of expectation, perceived performance and disconfirmation of belief. The theory was developed in a series of two papers written by Richard L. Oliver in 1977 and 1980 (Gibson, Papathanassis & Milde, 2011). It explains that consumer satisfaction is jointly determined by consumer expectation and the degree of confirmation between expectation and perceived performance (Oliver, 1980). This implies that individuals always have expectations and when the expectation is positively considered and performed, then the person is said to be satisfied. However, if the expectation is dashed or not performed, the person is said to be dissatisfied. Oliver (1977) explained that customer satisfaction and post-purchase behaviour are key elements of the theory. Fig 9 revealed the elements that determine consumers' satisfaction and dissatisfaction



Source: Oliver (1977)

The processes in which consumer reached satisfaction as illustrated by Oliver (1980) are: first, consumers form an initial expectation of a specific product or service prior to purchase. Second, they accept and use the product or service and will form perception about its initial consumption and its performance. Third, they assess its perceived performance in line with their original expectation and determine the extent to which their expectation is confirmed. Fourth, they form a satisfaction, or affect, based on their confirmation level and expectation on which that confirmation was based. Finally, satisfied consumers form a repurchase intention, while dissatisfied users discontinue its subsequent use (Oliver 1980; Bhattacherjee, 2001). When expectations, coupled with perceived performance, lead to satisfaction, then, the effect is mediated through positive or negative confirmation between expectations and performance. If a product outperforms expectations (positive confirmation), satisfaction will result; If a product falls short of expectations (negative

confirmation), the consumer is likely to be dissatisfied (Oliver, 1980). Since, consumers' intention to repurchase a product is influenced by the level of satisfaction they derived from the product, then, satisfaction is the key to building and retaining a loyal base of long-term consumers: "Investing in customer satisfaction is like taking out an insurance policy (Bhattacherjee, 2001). It is also important to understand that expectation as an additional determinant of satisfaction, because expectation provides the baseline or reference level for consumers to form evaluative judgements about the focal product or service (Bhattacherjee, 2001). Expectation-confirmation theory is widely used in the literature on consumer behaviour, marketing services.

The theory is highly significant in the field of information system. According to Bhattacherjee (2001) IS users' continuance decision is similar to consumers' repurchase decision because both decisions follow (i) an initial (acceptance or purchase) decision, (ii) are influenced by the initial use (of IS or product) experience, and (iii) can potentially lead to ex post reversal of the initial decision. Hossain and Quaddus (2012) revealed that ECT is broadly applied to examine the continuance intention of IS users rather than just to explain satisfaction. The theory has become one of the most popular theory in IS studies (Hossain and Quaddus 2012). Therefore, ECT provides a very useful framework for understanding how expectations shape satisfaction and the future consumer behaviour.

Summary

The importance of theories in human endeavours cannot be overemphasized, because of their useful in creating a sense of direction. This review has systematically discussed some of the theories used in the field of information communication and technology. The world has moved to the use of information system in a manner that is not negotiable. Its usefulness in terms of increasing productivity, efficiency and speeding up events has enhanced its

usage. However, as the usage increased, researches and advocacy will consequently rise. Therefore, formulation of theories to support the manner in which Information System is being adopted becomes reality. These theories are focused on ICT, why users adopt it and continue to use it. Where users discontinue adopting IS, the reasons for such behaviour are explored by the theories. Fundamentally, these theories showed that IS adoption has become a reality worldwide.

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Chapter **7**

INFORMATION SYSTEMS IN EDUCATION

Prof Eseza Akiror ERWAT
Lead City University, Ibadan, Oyo State, Nigeria
Email: erwat.eseza@lcu.edu.ng
+2348037278848

Philip Bamiji OLUSOLA
Lead City University, Ibadan, Oyo State, Nigeria
Email: Philip_bamiji@yahoo.com
+2348034173134

INTRODUCTION

Information Systems can simply be defined as a set of interrelated components that collects, process, store, and distribute information to support decision making and control in an organization. Information systems are drastically transforming the traditional methods of teaching, learning, communication, as well as administrative governance in our institutions of learning at all levels. It is amazingly integrating technology into the academic environment. Information systems are dynamically and radically equipping handlers of education to personalize instruction, enhance student engagement and ultimately boosting resource allocation to achieve maximum efficiency. This is bringing about efficient data management, communication enhancement, improving personalized learning experiences via tools such as Learning Management Systems, data analytics and digital content platforms. It is shaping modern education in a down-to-earth manner. Administrative efficiency is similarly gaining optimization in more efficient ways such as enrolment, attendance tracking and performance evaluation. All of these were discussed in this chapter.

Types of Information Systems in Educational Institutions

For clarification purposes, educational institutions referred to in this chapter include secondary and tertiary levels, research institutes, and government agencies such as ministries. Educational institutions engage various types of information systems to enhance their operations. These systems focus on teaching, learning, and administrative needs for the required efficiency and effectiveness. Ates (2020) listed some of them to include:

1. Communication Systems: These are systems that facilitate easy and fast communication. Tools like email servers, messaging platforms, WhatsApp platforms, and video conferencing tools such as Zoom and google meet for internal and external communication.
2. Administrative Systems: Administrative systems is all about structured processes and tools which organizations employ to manage and support their operations in an efficient manner. They assist in organizing, planning, controlling, and coordinating administrative tasks such as record keeping, decision making, resource management, and general office activities. Software for managing institutional operations such as finance, payroll, and human resources. For example, for finance management systems, SAP S/4HANA, Oracle NetSuite, QuickBooks, Tally ERP and Ellucian Banner Finance can be applied for financial planning, accounting and budget tracking, financial compliance and effective fund management in educational institutions. For payroll, ADP Workforce Now, Paycom, Gusto, and Paylocity would be appropriate for payroll management, tax compliance, employee service tools in educational environment; while Human Resource Management Systems can adopt Workday, Zoho People, BambooHR, PeopleSoft HCM and Ellucian Talent for effective talent management, employee database management, employee records, and management of faculty

and staff. All of the above can be customized to meet the specific needs of educational institutions.

3. Learning Management Systems (LMS): It is a software application or web-based technology used to plan, implement and assess a specific learning process. It consists of a server that performs the base functionality and a user interface. These are platforms like Moodle, Blackboard and Canvas. They are useful for online courses (e-learning), employee training, academic learning, managing course content, assignments, and assessments. Other platforms frequently used today for online lectures are Telegram, Googlemeet, Zoom, and WhatsApp platforms.
4. Student Information Systems (SIS): They are software platforms designed to manage, and store data related to students and their academic records. They enable educational institutions to digitize and manage student information efficiently. These systems help to improve communication between students, faculty, administration and parents. Examples are Gradelink, PowerSchool or Skyward that handle student records, grades, attendance, admission and enrolment.
5. Library Information Systems (LIS): This is also known as Integrated Library System (ILS). It is a computerised system that manages Library resources. An example of LIS is Open Access Catalog (OPAC) which provides users with access to a Library's or group of libraries databases of books, journals and other materials. Other tools used in LIS are Koha or WorldCat that assist in cataloging, tracking and accessing library resources.
6. Research and Data Management Systems: These are systems for managing research projects, data repositories, and academic publishing. Examples include Turnitin for plagiarism check or detection, Elsevier Pure (to track publications and measure research impact), InfoEd Global

(for research administration, compliance and reporting), Symplectic Elements (to manage research outputs and compliance with funding agency requirements), SPSS (Statistical Package for Social Sciences, for research data analysis), Microsoft SharePoint (to share documents and manage workflows), Zotero (a free tool for managing citations and references), Research Grant Management Systems such as Cayuse Research Suite (facilitates grant proposal submission, compliance and reporting), Pivot-RP (Assists institutions to discover funding opportunities), EndNote (for managing citations and bibliographies).

7. Office Automation System (OAS): These are systems that are used to collect digitally, store, transfer, alter, and utilize office information to execute tasks. They help to manage data. This system allows data to be transferred from one system to another without the need for manual labour or human involvement. The OAS conduct office-related matters and facilitate official activities at all levels of the organization. OAS comprises of email, voice-mail, word processing. It enhances efficiency and productivity by minimizing manual effort and ensures seamless communication and data handling. Examples of other OAS used in offices to facilitate office activities are Spreadsheets, Desktop Publishing and Corel Draw packages.
8. Geographic Information System (GIS): This is a computer system employed for capturing, storing, checking, and displaying data related to positions on earth's surface. This system is very useful in educational institutions basically for capturing and visualizing spatial and geographic data. They are useful for campus management, teaching activities and research purposes. Tools like Google Earth Pro, ArcGIS and QGIS. It can also be used in planning future school locations in an area.

9. Decision Support Systems (DSS) is an analytic platform that help administrators make data-driven decisions on student performance, resource allocation, and strategic planning. It is a web-based database that helps educational institutions and organisations in problem-solving and decision-making. The database stores the essential data and analyses it carefully in order to assist the administrator in taking appropriate action. An example of such a system is medical diagnosis provided by hospitals in universities and other educational institutions.
10. Management Information Systems (MIS): A management information system is a set of systems and procedures that collects data from a range of sources, compiles and presents such in a readable manner. This assists administrators by automating several operations that were performed by human element. The main features are data collection, data processing, information storage, and information dissemination. The Management Information System in the institution processes data to give appropriate (relevant, accurate, timely) information to those in management positions to make data-driven decisions. MIS facilitates decision-making, enhance efficiency, improves planning, and promotes integration. Examples of MIS in institutions are: Student Information Systems (SIS), Administrative Systems for finance management, payroll management and human resource management. These systems emphasize service through technology; therefore, data gathering/capturing, storage, analysis and dissemination of information for decision-making are the major functions. The information supplied is tailored to the needs of the administrators. The information enables them to see and assess the performance of the institution in order to make future plans/strategies for development.

11. Transaction Processing System (TPS): A Transaction Processing System is a sophisticated information system that enables organizations to manage real-time transactions. TPS assists a business with its day-to-day operations in a smooth and seamless manner. It executes this task by gathering the data extensively and making necessary modifications to it. One unique characteristic of this system is that it increases the overall performance and growth of essential transactions. TPS has the capacity to process large volumes of repetitive and routine transactions with reduced human intervention accurately and efficiently. TPS enhances fast, accurate and efficient transactions (accounting, financial data). It generates information efficiently for other systems both internal and external and are used by operational personnel. They are used for payroll processing, inventory management, sales and order processing as well as accounts payable and receivable. Examples of TPS include ATM transactions in banking and POS (Point-of-Sale) for retail sales. Institutions have branches of banks operating within their premises or there are ATM machines available for users. The ATM and POS facilitate financial transactions such as online payment of school fees and other sundry bills.

Benefits of Implementing Information Systems in Educational Institutions

As defined in the introduction above, Information Systems are interrelated components working together to collect, process, store, and disseminate information to support decision making, coordination, control, analysis, and visualization in an organization (Laudon and Laudon, 2012). The justification for implementing information system in educational institutions has been documented by Adams (2003). Some of the benefits listed for business organisations include: Operational efficiencies, dramatic cost reductions, supply of information to decision-makers, better customer

service, continuous availability of the systems, and growth in communication capabilities and methods. Other benefits include better safety, competitive advantage, fewer errors, greater accuracy, higher quality products, and improved communications.

Relating the benefits of implementing information systems directly to educational institutions, the following are noteworthy:

1. Improved Efficiency: Automating reoccurring activities such as students' admissions, attendance, and grading reduce manual effort, saving time and significantly conserves resources.
2. Administrative systems simplify processes such as fee management, payroll, and inventory control to allow operational efficiency.
3. Improved Communication: Platforms for emails, messaging, and virtual meetings significantly enhance communication between learners, teachers, as well as administrators.
4. Enhancement of Learning Experiences: Useful academic tools such as Learning Management Systems (LMS) provide personalized learning, interactive content, and flexible access to educational resources.
5. Data-Driven Decision-Making: Information systems allow educational institutions to analyse student academic performance, enrolment trends, and resource utilization to support informed strategic planning.
6. Increased Accessibility: Online systems make education more accessible by providing remote learning opportunities and access to digital libraries.
7. Enhanced Security: Robust information systems ensure intact and secure storage of sensitive data, such as student records and financial information.
8. Research management systems provide tools for data analysis, collaboration, and publishing, supporting academic research activities.

Srivastava (2016) noted that ICT offers increased possibilities for codification of knowledge about teaching and for innovation in teaching activities through being able to deliver learning and cognitive activities anytime and anywhere. This enhances accessibility to education to all those who desire it. Implementing information systems in educational institutions across the nation will no doubt create a more inclusive, effective, and innovative learning environment.

Implementation of ICT in our educational institutions offers increased possibilities for codification of knowledge about teaching and for innovation in teaching activities anytime, anywhere. It is now globally acknowledged that ICT tools stimulate teachers. A good number of teachers practically engage ICT to accomplish difficult tasks in our educational institutions today. Activities such as research, preparation of courseware and lecture materials, lecture delivery virtually or via projectors, online teaching, preparation of voice notes for learners, distant learning, and many more academic activities are done with the aid of ICT in a seamless manner.

In the developed climes, the use of ICT in education and training is a priority. Findings of a study conducted some years ago have established the fact that ICT has pervading impact on students' performances in schools. It has also been found through the study that schools with sufficient ICT resources achieved better results than those that are not well equipped. Teachers have become more convinced that educational achievement of students are due to good ICT use (Blanskat, Blamire, Kefala (2006) in Srivastava (2026).

ICT implementation facilitates access to quality education for all, including remote learners. It enhances teacher-student engagement and supports innovative teaching methods. It improves institutional efficiency and data-driven decision-making. By adopting a well-planned and inclusive approach, the implementation of ICT in

education can significantly enhance learning outcomes and transform educational systems.

It should be noted that Information Systems talks about a broader concept embracing the people, processes, as well as technology used to collect, and analyse data to support decision-making within an organization; whereas, ICT focuses on the technical infrastructure and the communication tools used to facilitate information flow, including hardware, software and networks. Information Systems utilize ICT as a component to achieve its goals.

Challenges of Adopting ICT in Education and Suggested Solutions

Despite the array of vital potentials underlying the adoption of Information and Communication Technology (ICT) in education, there are many challenges that must be addressed to maximize its numerous benefits. Some of the many challenges listed by Nwambela, Mondoh and Thoruwa (2019) are – Limited ICT infrastructure, low digital literacy, affordability and accessibility, language and content localization, cultural and social factors, access to information and knowledge. Other challenges noted by Smarkola (2007), include costly internet access, limited information sharing, limited skills for integration of ICT, shortage of trained technicians, limited electricity supply, poor telephone connectivity and inadequate number of computers. Similarly, Hare (2007) considered lack of policy framework, inadequate infrastructure, high cost of bandwidth and inadequate in-service training of teachers on ICT in education. According to Andoh (2012), one of the challenges in the use of ICT is the breakdown of computers which causes interruption in the use of ICT in teaching and learning.

1. Infrastructure Deficits: Many institutions lack adequate ICT infrastructure, such as computers, internet connectivity, and reliable power supply.

2. High Costs: ICT tools, maintenance, and software licensing can be expensive for educational institutions.
3. Digital Divide: Inequity in access to technology among students from different socioeconomic backgrounds can widen the learning gap.
4. Resistance to Change: Teachers and administrators may be resistant to adopting new technologies due to lack of awareness, fear of obsolescence and unwillingness to learn new things such as using of ICT.
5. Lack of Teacher Training: Insufficient technical skills among educators hinder effective use of ICT in teaching.
6. Content Relevance: Limited availability of localized, culturally relevant digital content could hinder adoption.
7. Cybersecurity Concerns: Increased use of ICT exposes institutions to risks like data breaches that can lead to data loss, theft and cyberbullying.
8. Technical Support Gaps: Limited access to technical support can disrupt learning activities.

Solution to the Challenges

The following are solutions that would effectively address the challenges as mentioned above:

1. Governments, philanthropists, and stakeholders should invest in infrastructure development, especially in critical areas, and promote public-private partnerships.
2. Deciding for open-source software and negotiate subsidized rates for hardware and connectivity from service providers.
3. Provision of low-cost or free devices to indigent students.
4. Conduct awareness campaigns and provide incentives for adopting ICT tools.
5. Implement regular, comprehensive training programs to equip teachers with necessary digital competencies.

6. Encourage the development of localized content by collaborating with educators, content developers, and government agencies.
7. Implement robust cybersecurity measures, create awareness programs, and establish clear policies for ICT usage.
8. Establish dedicated ICT support teams within institutions and provide remote troubleshooting options.
9. Proper maintenance of the available ICT resources.
10. Establishment of community learning centres with internet access.
11. Reduction of teachers' workload.
12. Provision of reliable power back-ups in case of power outages.
13. Provision of stronger and reliable internet.

To effectively harness the opportunities of ICT in educational institutions, the implementation of an array of suggested solutions as itemised above are sacrosanct in effectively addressing the identified challenges.

Implementation of ICT in Education

It is noteworthy that as soon as Information and Communication Technology (ICT) is fully implemented in educational institutions, students are naturally more open to change than they usually are as ICT helps students to become less dependent on teachers as expert. Implementation of ICT in education is a transformative process that enhances teaching, learning, and administration. It involves integrating technology into various aspects of educational systems to improve access, quality, and efficiency.

ICT is now a common phenomenon in virtually all aspects of life. ICT implementation in educational institutions is one factor that is assuming wide recognition and fast gaining the attention of scholars the world over. Srivastava (2016) in Daniels (2002) noted that ICTs

have become within a very short time, one of the basic building blocks of modern society. The scholar observed that a number of master plans on ICT has revealed that educational innovation in ICT have been increasingly embedded within a broader framework of education reforms that aimed to develop students' capacities for self-learning, problem solving, information seeking and analysis, and critical thinking, as well as the ability to communicate, collaborate and learn, abilities that figured much less important in the curricula.

Steps in Implementing ICT in Education

1. *Policy Development and Planning:* develop clear ICT policies and frameworks that align with national education goals; define objectives, priorities, and timelines for implementation.
2. *Infrastructure Development: e*nsure access to basic infrastructure, including hardware (computers, tablets, smartboards), software, and internet connectivity; address power supply challenges, especially in rural areas, by incorporating renewable energy solutions like solar power.
3. *Teacher Training and Capacity Building:* provide comprehensive training programs to equip educators with ICT skills; include ICT pedagogy in teacher education programs to encourage effective integration into teaching practices.
4. *Development of Digital Content:*
   Create engaging, localized, and curriculum-aligned digital content to meet the needs of diverse learners; encourage open educational resources (OER) to enhance accessibility and cost-effectiveness.
5. *Integration into the Curriculum: e*mbed ICT tools into teaching and learning processes to promote interactive and personalized learning experiences; use Learning Management Systems (LMS) and e-learning platforms to support blended learning approaches.
6. *Promoting Equity and Accessibility: b*ridge the digital divide by providing affordable devices and internet access to

underserved communities; implement assistive technologies to support students with disabilities.

7. *Monitoring and Evaluation: r*egularly assess the effectiveness of ICT initiatives to identify gaps and areas for improvement; collect and analyse data to inform policy adjustments and ensure sustainable growth.
8. *Strengthening Partnerships:* collaborate with governments, private sector stakeholders, NGOs, and international organizations for funding, training, and technical support.

In addition to the above points, Srivastava (2016) in Mooij and Smeets (2001) underscores five successive phases of ICT implementation, which are:

1. The incidental and isolated use of ICT by one or more teachers;
2. Increasing awareness of ICT relevance at all levels;
3. Emphasis on ICT coordination and hardware;
4. Emphasis on didactic innovation and ICT support; and
5. Use of ICT-integrated teaching and learning that is independent of time and place.

Summary

This chapter discusses the role and impact of Information Systems (IS) in education, underscoring their transformative potential in modernizing teaching, learning and administrative processes. The concept of information systems was introduced highlighting their relevance in educational institutions. Different types of systems were discussed, including Executive Support Systems, Learning Management Systems (LMS), Student Information Systems (SIS), Library Information Systems, and Decision Support Systems, all of which contribute to improved efficiency, accessibility, and data-driven decision-making.

The benefits of adopting Information System were outlined, stressing implementation of large set of innovative teaching practice, standard-based approach, competency-based approach, task-based learning, enhanced learning experiences, streamlined administration, and better communication. However, challenges such as infrastructure deficits, the digital divide, and resistance to change, among others were identified as barriers to widespread adoption. Practical solutions, including teacher training, infrastructure investment, and policy reforms among others were suggested to overcome these obstacles.

The chapter concludes with an in-depth discussion on the implementation of ICT in education, detailing steps such as policy development, infrastructure enhancement, teacher capacity building, and equitable access to technology. By painstakingly addressing all of these, the chapter stressed the potentials of Information System and ICT to revolutionize education to make it well accessible, efficient, and inclusive.

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Chapter **7**

DATA PROCESSING

Olusegun Samuel Olaniyi, & Idayat Ajoke Oderinde
Department of Educational Management
College of Specialised and Professional Education
Tai Solarin University of Education, Ijagun, Ogun State, Nigeria
Corresponding Email: olaniyios@tasued.edu.ng
Mobile Phone: +2348052472953

INTRODUCTION

Data are a collection of discrete or continuous values that convey information, describing the quantity, fact, statistics, other basic units of measuring, or simply sequences of symbols that may be further interpreted formally. It is a collection of information gathered by observations, measurements, research or analysis. It may also be described as consisting of facts, numbers, alphabets, word, code, symbol, names, figures or the assignment of identifications to things. In statistics and other mathematical science, data can be organized in the form of tables, graphs and charts. Data in their raw forms might not be so important for making decisions except they are processed. However, they are facts necessary for further refining of information. They are the foundations to good information. Data is an essential component of many fields of study, including mathematics, business, economics, science, and statistics. The term 'qualitative' describes the quality of something or someone. It contains descriptive information. For example, human complexions (either black or light), gender (male or female), sizes in height (tall or short), student's programme, city of origin, feelings towards mathematics give qualitative information about a person.

On the other hand, the term quantitative provides numerical information, for example, test scores, volume of water in a container, inflation rate of each year in the 2000s, the height, and weight of a person (Cheung, 2023). Data are collected through observation, measurement, query and data collection techniques, and they are usually represented as numbers or characters which may be further processed. They can also be analyzed using reasoning, discussion, presentation, calculation, visualization, etc. They are classified either in qualitative manner or quantitative manner. Qualitative data is gathered through interviews and observations and analyzed by categorizing information to understand themes and insights. Quantitative data on the other hand is collected through methods like surveys and experiments and analyzed statistically to identify patterns (The Fullstory Education Team, 2021).

DATA PROCESSING

By definition, data processing is the process of converting raw data into meaningful information. According to Terra (2024), data processing is the method of collecting raw data and changing it into usable information. Huang (2019) defines it as the extraction of information through organizing, indexing and manipulating data.

The earliest records of storing or processing data were different cave images and inscriptions to record best practices and danger. Later, the earliest computational device was the Abacus, invented in ancient Egypt. Other significant contributions towards data processing development and computation were made by Napier, Pascal, Leibniz, and Charles Babbage -who designed the first computer called analytical engine (Dutta, 2022). Today, when referring to data processing evolution, it is believed that it is the same as computer evolution or the history of the computer. The technologies handling big data today are unprecedented, as we bid farewell to the challenges of the past, the future of data processing has been made easier with the aid of cloud computing. Prathamesh Kulkami- a senior

lead data designer published in November 2023 that the evolution from mainframes to virtualization and cloud technologies has paved the way for unimaginable possibilities. Even now, Artificial Intelligence (AI) is making waves and it is gaining acceptability by handling tasks that seem difficult to humans globally. In the ever-evolving landscape of data processing, the journey before and from the 1980s to the present day can be regarded as being transformative. In the past, mainframes computers (emerged in the 1980s), Oracles and SQL Server (in the 1990s), rise of data warehouses and BI tools such as Informatica, Datastage, Cognos, and Business Objects (in the 2000s), Hadoop and Spark (emerged in 2014), cloud revolution (emerged in 2018), and latest, Delta Lakes and ACID capabilities (emerged in 2020) for handling traditional relational databases achievable in the data realm (Kulkami, 2023). Of course, with a series of transformations in data processing over the years, the future of business data processing will be dictated by the type of technology that companies intend to use to process their information.Without data processing, organizations/educational institutions limit their access to the very data to enable them deliver to their expectation for the achievement of goals and objectives.

a. Data processing is the series of operations performed on data to transform, analyze, and organize it into a useful format for further use. The goal of data processing is to extract pertinent information that can be applied in decision-making processes or support existing technologies. To achieve this, data engineers and data scientists employ a range of data processing tools and techniques, ensuring that the output is both accurate and valuable. Data processing happens when information is collected and transformed into something useful. It is often done by a data scientist or a team of them. It is crucial to get it right so that the final result, or data output, is not messed up. First, you collect data from different places. Then, you arrange it so that it can be understood by the computers or data processing machines. After that, special computer tools analyze and work

with the data, pulling out important details. The end result, like charts or reports, is what we get in the output phase. According to the National Open University of Nigeria-NOUN (2008), the scope of data processing system covers the following:

- Data collection
- Data capture
- Data recording
- Data entry
- Data transmission
- Data sorting
- Updating of information
- Adding of data
- Deletion of information
- Data validation
- Data verification
- Summarizing of data
- Printing of results
- Summaries of data for management decision
- Calculating data
- Comparing data
- Statistical reports
- Data mining

The stages or cycle of data processing are shown in figures 1 and 2, as follows:

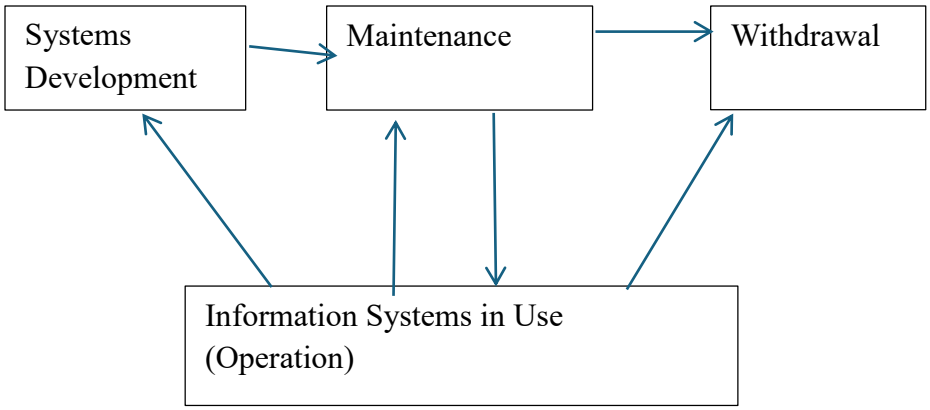

Figure 1: Stages/Cycle of Data Processing
Source: Laudon, K.C., & Laudon, J.P. (2019). *Management information systems: Managing digital firm*. Pearson

STAGES OF ELECTRONIC DATA PROCESSING

Input Stage

This is the first stage in the data processing cycle. It is the stage in which raw data begins to take the form of usable information. It involves the capturing and collection (gathering) of data. The difference between data collection and data capture is that data capture involves the process of obtaining data in a computer-sensible (machine-readable) form. But data collection is the process of getting the original data to the place where it is to be processed by converting it from one medium to another, and later getting it into the computer. Encoding involves the use of codes or instructions that the computer understands to be able to carry out intended activity for meeting the goals of the organization. As soon as data is collected, raw data is diligently checked for any errors. The purpose of this step

is to eliminate bad data, redundancy, as well as incomplete or incorrect data and begin to create high-quality data for further usage.

Processing Stage

This is the stage where the data acquired are acted upon using different codes and instructions. The data in its raw form should be processed in order to give out information. This activity involves performing instructions and transforming/refining raw data into information.

Output Stage

This is the stage where the results of the data processed are released. This output stage shows the refined data. At this stage, data has been transformed into information. It is the stage at which data is finally usable to non-data scientists. It is translated, readable, and often in the form of graphs, videos, images, plain text, and so on.

Storage Stage

This is the final stage in which the results of all activities carried out are being kept for future use. This stage stores data and retrieve data when needed.

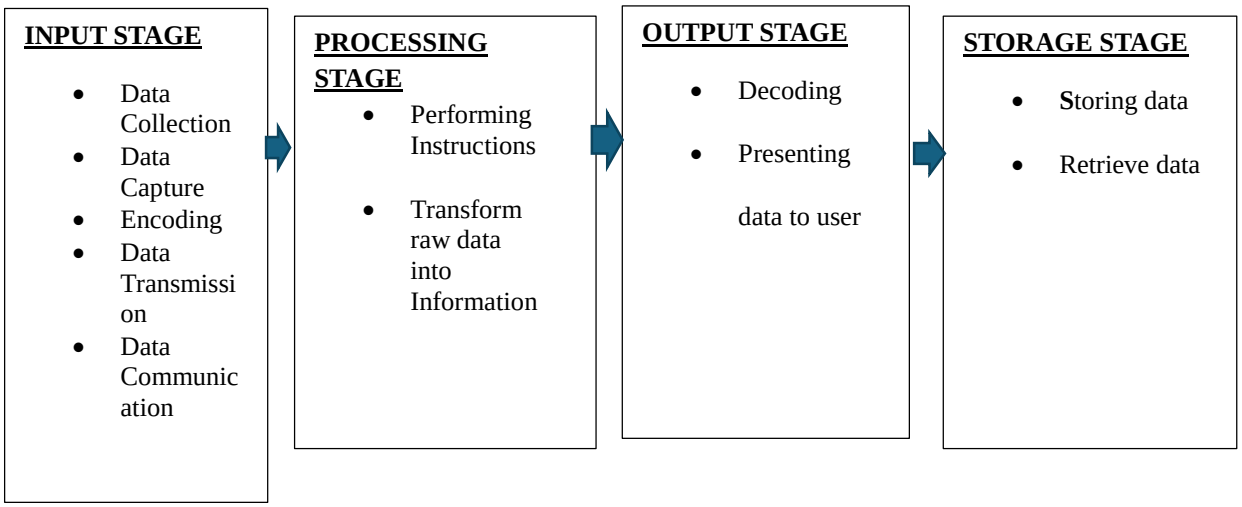

Figure 2: Stages of Data Processing Cycle
Source: Hang (2019)

EXAMPLES OF INSTITUTIONS USING DATA PROCESSING

The following institutions process data based on the equipment available for them.

1. Health Institutions: Electronic Health Records (EHRs) store and process patient data in healthcare settings. This includes medical history, test results, and treatment plans, facilitating efficient and accurate healthcare delivery.
2. Financial Institutions: Places like banks and insurance institutions collect data of their customers and process them for continuous operations. Another institution is stock exchange offices where they process a massive volume of data during trades. The system matches buy and sell orders, updates stock prices in real-time, and records transaction details to maintain an accurate and transparent market.
3. Police/Military Formations: Police/military establishments use data processing for crime records, prevention and control.

These records can help in studying dominant crimes in a given society.

4. Legal Institutions: Institutions like the judiciary also make use of the knowledge of data processing for the records of cases brought before the judges based on the level of severity.
5. Educational Institutions: Universities, colleges and schools are also collecting and processing data about their students for immediate and future purposes. Students that have graduated from schools might want to get their certificates, records of academic performance or transcripts years after their graduations, it is the data about the students that would fish out such academic records. Examination bodies also collect data of their candidates so that the issue of impersonation can be guided against.

FUNCTIONS OF DATA PROCESSING

Data processing functions include:

a. *Validation:* It is the way to ensure that data supplied is correct and relevant.
b. *Sorting:* This means to arrange data in some sequence or forms.
c. *Summarization:* This deals with reducing detailed data to its main points.
d. *Aggregation:* This means combining multiple pieces of data.
e. *Analysis:* When data is collected and sorted, it gives a picture that could be interpreted and making decisions.
f. *Reporting:* This is about the presentation of data to the appropriate quarters in a form that others can see it and make judgment
g. *Classification:* This is an act of separating data into various categories.

IMPORTANCE OF DATA PROCESSING

Data processing is important for the following reasons:

a. *Making data understandable:* Raw data is often like an unreadable book. Data processing transforms this raw information into a readable and understandable format. It organizes, structures, and arranges data so that humans and computers alike can understand and interpret it.

b. *Informed decision-making:* In every aspect of life, decisions are made based on information. Processing extracts valuable insights from raw data, providing a foundation for informed decision-making. Whether in business, healthcare, education, or daily life, processed data guides choices that can lead to better outcomes.

c. *Identifying patterns and trends:* Data processing helps reveal hidden patterns and trends within the information. Whether it's understanding consumer behavior, predicting weather patterns, or identifying market trends, processed data allows us to recognize and leverage patterns that may not be apparent in raw data.

d. *Enhancing efficiency:* Just as a well-organized workspace improves efficiency, processing streamlines information. It makes data accessible and ready for use. It reduces the time and effort required to find relevant information. This efficiency is critical for businesses and organizations looking to optimize their operations.

e. *Visual representation:* Humans are visual creatures, and processing enables the creation of visual representations such as graphs, charts, and reports. These visual aids make complex information more digestible, allowing individuals to grasp insights quickly and make sense of data at a glance.

f. *Predictive analysis:* Data processing is not just about the past; it also helps predict future trends. Analyzing historical data, patterns, and behaviors enables predictive analysis. This capability is particularly valuable in fields like finance or

healthcare, where anticipating disease outbreaks can be critical.

g. *Automation and artificial intelligence:* With the rise of automation and artificial intelligence, processing has become the backbone of these technologies. Automatic data processing enables machines to learn from data, make decisions, and perform tasks without explicit programming. This, in turn, leads to increased efficiency and innovation across various industries.

h. *Improving accuracy:* Raw data may contain errors or inconsistencies. The data processing system includes validation and cleansing steps that improve the accuracy of the data. This is essential for making reliable decisions based on trustworthy information.

METHODS OF DATA PROCESSING

There are three main data processing methods, namely:

a. Manual Data Processing

Manual data processing method depends on human efforts in managing and manipulating data. The method involves activities like sorting (arranging), calculating, and recording information without the use of machines or electronic devices. The demerit in this method lies in the fact that it is prone to errors, inefficiency and time-consuming. Manual data processing methods could only be relevant in situations where other data processing methods are not available and human judgment is required. For example, in a school where inventory of school materials are to be taken in school, and the physical signature of those concerned are needed. Also, in the inter-house sport competition where human judgment is needed for assigning positions and giving prizes to the winners.

b. Mechanical Data Processing

This method involves the use of machines such as adding machines, typewriters, printing presses and mechanical calculators to handle data. It represents an intermediate stage between manual and electronic data processing. Although, it offers better efficiency than the manual methods. This method lacks the use of the computer for processing and storage of data. For example, the use of this mechanical data processing is still in vogue among smugglers and market women in the less-urban communities. Although, this method was in operation in some cities too before the coming of the personal computers.

c. **Electronic Data Processing (EDP)**

Electronic data processing method adopts the use of computers and digital technology to perform data-related tasks. It has revolutionized data processing activities through its speed, accuracy, and storage capacity. Electronic data processing has various techniques of processing data which include batch processing, real-time processing, and online processing among other modern information management techniques. For example, electronic data processing can be found in schools, hospitals, pharmacy stores, manufacturing industries, airports, embassies, and other private and governments' establishments. All these aforementioned establishments make use of computers to process data accurately with speed. The basic elements of electronic data processing include the hardware, software, procedure, and personnel. Examples of electronic data processing are: (i) to format bills and to calculate the usage-based charges, especially in telecom companies, (ii) hotel reservations, (iii) learning institutions, (iv) examination boards such as Nigeria's Joint Admission and Matriculation Board (JAMB), and West African Examination Council (WAEC), (v) Crime prevention and control by the Police, and (vi) barcode scanner.

The following are the major types of data processing:

Business data processing:

This involves the use of certain relational databases that use batch processing. It is used for commercial purposes, especially in the banking sector and other financial institutions that have very large data to be processed. The data managed by this system is generally standardized and thereby devoid of errors. There are three types of business data processing, namely; i) data warehouse, ii) business intelligence, and iii) big data processing. *Data warehouse* stores transactional or operational databases for the future. *Business intelligence* analyses business information with various tools to make better decisions. *Big data processing* collects large amounts of data from various sources for analysis (Technology Counter Blog, 2023).

Scientific data processing

The scientific process of data takes more time than the business data processing. Scientific data processing involves the use of the arithmetic/mathematical or logical procedure to carry out difficult tasks. This can also be used for scientific experiments in laboratories. At times, it involves the use of programs with programming languages suitable for scientific operations. Other types include:

b. ***The Batch processing:*** In this processing technique, data is collected and processed in batches. This method is normally used for large amounts of data.

c. ***Online processing:*** This is used for continuous data processing. This processing technique automatically feeds data into the Central Processing Unit as soon as it is available.

d. ***Real-time processing:*** This processing technique gives the results immediately as the system processes data. Data is processed within seconds when the input is given. The computer quickly processes data, skipping entries that have errors and continuing to process the next set of data. It is used for small amounts of data.

e. ***Distributed processing:*** This processing occurs when information is present on multiple machines and servers. This processing technique is good on its own because data processing can continue on other servers even when one server is faulty.

f. ***Multi-processing:*** This is the processing of more than one task that uses different processors at the same time on the same computer. It is possible in network servers and mainframes.

g. **Multitasking process**: In this processing technique, various tasks share the same processing resource. The operating systems in the multitasking process are time-sharing systems.

SIGNIFICANCE OF ELECTRONIC DATA PROCESSING (EDP) ACTIVITIES

The Electronic data processing activities includes:

1. ***Reliable back up****:* EDP ensures a reliable back-up system once your data has been digitized, which can store both on-site and off-site. To ensure safety during natural disasters, theft or proliferation of data, off-site storage is essential. Data processing managers need to ensure proper back-up systems are made while processing data.

2. ***Enhanced data Security and Control:*** Since traditional filing system may not be sufficient at times, the use of electronic data processing ensures data are under control and safe, reliably. During EDP, your data can be moved to the cloud. The cloud computer has provided a better means to set data under control, and they are easy to be retrieved when needed.

3. ***Better coordination and workflow:*** EDP also helps to create and execute workflows of information, and thereby enhancing

internal and external collaboration. Data processing gives better coordination and flows of work.

4. ***Improved timeliness:*** Today, EDP makes it possible for most employees and employers to work from home and remote locations, while gaining instant access to information they require. It is easier to share and access digital files than traditional paper files.

5. ***Increased Efficiency and File Management:*** With EDP, employees are relieved of the task of flipping through thousands of files to find a particular piece of data, which may take up many hours. EDP manages data efficiently without much stress. Data is retrieved easily and they remain at your fingertips.

8. ***Easy report making and access:*** With EDP, finding information is made easier from the indexed content, which ensures improved decision making and reduces the amount of time looking for information. Data management software like Optical Character Recognition will enable you to convert different types of documents, such as scanned paper documents, PDF files and more editable and searchable data that is easy to store and organize.

9. ***Enhanced task management for better result and productivity:*** Management of activities and task are enhanced using electronic data processing. It remains the best method of data processing across the globe. According to SiteProNews (2023), an organization with access to the right data always has an advantage over its competitors.

10. ***Accuracy and speed:*** Electronic data processing (digitization) is devoid of errors, and it is so fast in operations.

11. ***Cost reduction:*** EDP decreases expenditure on stationery such as photocopies and mailing by using digital information and email systems.

USES OF DATA PROCESSING

Electronic data processing is useful for the following:

1. ***Optimizing organizational efficiency:*** Data processing helps administrators and managers of organizations to identify and guide against any factor that could result in a waste of resources, time and efforts. Organizations aiming to optimize their forecasting can also make use of data processing.
2. ***Judicious Resource Distributions:*** Data processing is helpful in analyzing, allocating and distributing resources.
3. ***Monitoring deliveries:*** Data processing also helps in the monitoring of package deliveries to efficiently arrange for the delivery of goods.
4. ***Task sequencing:*** With data processing, an organization can determine the most optimal sequence of tasks and make decisions accordingly.
5. ***Operation research:*** Data processing can solve problems relating to the coordination and optimization of its activities. This leads to the effectiveness of operations, guiding decision making and improving the planning process efficiently.
6. ***Route optimization:*** Aviation, courier and other service providers need electronic data processes today to carry out their services effectively and efficiently, which would allow them to have robust and comprehensive services to their clients.

Summary

Data processing is the backbone of information management, enhancing efficiency, promoting accuracy, and swift decision-making. From traditional manual methods to the cutting-edge electronic processing, the evolution of data processing methods has

transformed how data is being collected, analyzed, and stored. The present day data processing is being enhanced by cloud computing and Artificial Intelligence (AI). The future of data processing will be dictated by the type of technology that business organizations accept for processing their information. But, it is expected that the future data processing technology will be capable of handling big data effectively and efficiently, and information can be received in a twinkling of an eye, just to describe its efficiency more than what it is now.

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Chapter 9

SYSTEM ANALYSIS AND MIS IN EDUCATION

Kwaji Tizhe Takwate (PhD)
Department of Arts & Social Sciences Education
Adamawa State University, Mubi – Nigeria
takwate637@adsu.edu.ng
+234-07061269085

Introduction

The concepts of system analysis have entered almost all areas of endeavours, because of its structural association with logical, rational and critical way of thinking. It is also included in series of the most pressing analytical issues of today's era. The concept of system analysis cut across all economic sectors and because of that, it is relevant to pinpoint that it might be very difficult for a nation to achieve a progressive modern education without leaning on frequent analysis of its education system. A bitter truth needed to be told to say that African countries have lagged behind in terms of their education pursuit for some years now and this is despite the fact that without education it is impossible for a nation to train personnel that are in line with modern demand. The synergetic methodology used in the implementation of education policies is an important direction in education achieved through system analysis and it serve as a basis for modern integrated education. Nowadays, educational process of the world is so advanced that developed countries are able to achieve high economic potential with only the mind, without spending any additional material and natural resources or without using any inertia (Khotambekovna, 2021). This means that by properly setting up good reforms in the education system based on

system analysis, it is possible to achieve economic growth through education even without exerting much effort and labour.

System analysis in education is an approach that is consistent with modern education, which proves that synergistic education analysis is integral, critical and logical thinking, constantly evolving, working tirelessly on itself and it does not allow stagnation in the educational process (Ajibade, 2019). Educational process as an object of system analysis is a set of interconnected controlled elements with a specific structure, each of which performs a specific function. System analysis is specific to complex systems and educational process is complex because it consists of interconnected elements (primary education, secondary education, tertiary education, teachers, learners, parents, government etc.) it is appropriate for us to use it in education. These elements are interconnected and strive to achieve common goal, performing the functions necessary to achieve that goal. But it should also be borne in mind to ask the question: Is education really treated as a system so as to develop as a whole? Does each element or part in the system move on its own? Or can we also ask if education really is considered a system? Is every element of the educational process working together to improve the level and quality of education? Many such questions demand for answers. In order to answer these questions, we need to explicitly understand the term system, system analysis, components of a system and system analysis in education in this Chapter.

Meaning of System

The word System is derived from a Greek word *Systema*, which means an organized relationship between any set of components to achieve some common cause or objective. A system is an orderly grouping of interdependent components linked together according to a plan to achieve a specific goal. Others (Sindhu, 2012; Khotambekovna, 2021) define system as a complexity of elements in mutual interaction in such a way as to constrain action toward the

accomplishment of the purposes for which the system exists. Simply stated, a system is a collection of entities or things (animate or inanimate) which receives certain inputs and is constrained to act upon them (process) to produce certain outputs, with the objective of maximizing some functions of inputs and outputs (Lalande & Baumeister in Mwangeka, 2020). Figure 1 describes the components of a system functioning within a confined environment with specific boundaries.

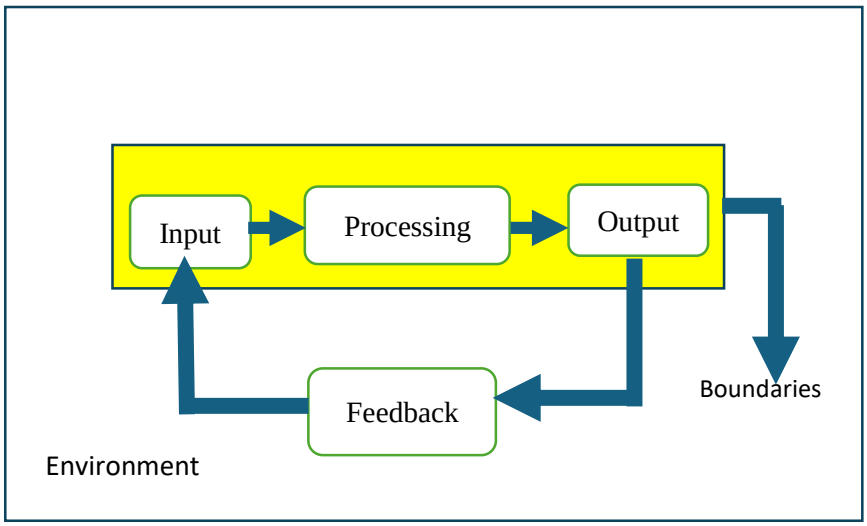

Figure 1: *Components of a System*

Within a system (Figure 1) exists inputs, process, outputs, boundaries and environment as elements of its components. *Inputs* are the human, materials, financial, or information resources used to produce a product or a service. It also consists of education facilities (Takwate, 2018), students' characteristics (prior learning), teachers (experience) (Moja, 2000). *Process* is what transforms input into output. Through technology and administrative functions, the inputs undergo a transformation process. In school for example, the interaction between the students and teachers is part of the transformation or learning process by which students become

educated citizens. The processing stage consists of teachers' styles and techniques, school administrators' style and technique and also programme operation. *Outputs* is the organization's products and/or services. In school, graduates as educated citizens are examples of education's outputs and it include the students' achievement, attitude and behaviour. *Feedback* is the information given concerning the outputs or the process of the organization that may lead to changes in both the process and in the future outputs. In the interrelationship that exist between input and output, feedback plays a very important function. Feedback is like a reaction a performer gets from the audience. Similarly, the school system gets information from the environment or society as to how it has performed. Feedback tells whether a certain education plan should be continued or not. Positive feedback is routine in nature that encourages performance while negative feedback is informational in nature that provides the controller with information for action. For this reason, all educational development plans are made on a rolling basis, meaning, they are subject to modifications, revision, or changes depending on the feedback after some time of operation.

A system is defined by its *boundaries* (Moja, 2000). Boundaries are the limits that identify system's components, processes, and interrelationship when it interfaces with another system to determine its sphere of influence and control. System boundaries determine what is to be included or excluded from the system. For example, the educational system may be defined by levels, that is, primary, secondary, and tertiary education. Any kind of system (school, business, industry etc.) is always situated in an *environment*. The environment is the "supersystem" within which an organization operates as a "subsystem". The environment is what surrounds the organization (social, political, and economic factors) that impinge on the organization. It is the source of external elements that strikes on the system to determine how it must function. For example,

competitors of organization's environment provide constraints that affect the actual performance of the business.

Basically, all organizations are considered an open system since all the factors outside the organizations can influence their stability. The components of a system work in an integrated or interrelated manner. This to say, each system has, above all, the property of integrity. That is, the integrity of a system is such that its essence as a system is lost when it is broken down into individual parts. The education system itself is one of the most important types and elements of an entire social system. Education as an integral element of the social system consists of a set of various structurally and functionally related components (primary, secondary and tertiary level) that serve the purposes of educating and nurturing people and the younger generation through effective planning, analysis, organizing and managing of the educational process.

What is Analysis?

The concept 'analysis' has the following classifications: 1. The study of an object or an event in terms of essence, law, and other aspects; 2. To study, evaluate something, information, etc. from a certain point of view; 3. Determining the composition of something and studying its essence (Arnold, & Wade, 2015). So when we systematically analyze the educational process, we first look at it as a complex system consisting of integral, interconnected elements. Then we examine the laws, Acts, ordinances, rules and essence of this complex system, approach the education system from a synergetic point of view and study the essence of education in a new way.

Among the classic works on the theory of systems are the works of the Ludwig von Bertalanfi (1901-1972). In the process of systematic analysis, a specific system is examined from the environment, its composition is determined, structures, functions, integral features, as well as the factors that make up the system and it relationship with

the environment are analyzed. System approach applies to sets of objects, individual objects and their components, as well as the properties and integral properties of objects. That is why the support of students, even the issue of student are considered in the allocation of some school resources (Harris et al, 2006; Arnove, 2009).

System Analysis

Systems analysis is a problem-solving technique that decomposes a system into its component pieces for the purpose of studying how well those component parts work and interact to accomplish their purpose. According to Vazquez-Abed (1982) and Moisev in Khotambekovna (2021), system analysis is a set of methods based on the use of computers and aimed at studying complex systems - technical, economic, environmental and others. It has the assumption that no comprehensive system development (like education) can take place without prior system analysis (Sindhu, 2012). It enables administrators to use more scientific and quantitative methods for analyzing management problems.

It is possible to distinguish the specific strengths and weaknesses of applying a systematic approach in the modern educational process. The strength of system analysis is that it constantly stems from specific needs, influences practice, constantly expands the scope of research objects, and cannot be left out of society's real needs. Today, it is the development of the educational process and the issue of material well-being that has become a basic need of our society. The weakness of system analysis is that this method of analysis sometimes makes decisions as a result of the use of underdeveloped methods of system research, which in turn leads to the neglect of real problems. Such cases may occur during the research process, but can be resolved later on the basis of consistency and graduality.

Vazquez-Abed (1982) and Bentley (2007) defined systems analysis as the process of studying a procedure or business to identify

its goal and purposes and create systems and procedures that will efficiently achieve them. System analysis relates closely to requirements analysis or to operations research. It is also an explicit formal inquiry carried out to help a decision maker identify a better course of action and make a better decision than they might otherwise have made. System analysis is used in every field where something is developed such as education. The ultimate goal of system analysis is to address the problem situation that has arisen in the object of system research (a particular organization, community, enterprise, individual region, social structure, etc.) and that is why it is good to apply it in solving problems in the education system. System analysis is conducted for the purpose of studying a system or its parts in order to identify its objectives. It is a problem solving technique that improves the system and ensures that all the components of the system work together efficiently to accomplish their purpose.

System Analysis in Education

The term 'systems analysis' was formed from two English words: systems and analysis. The term system means entirety or wholeness, in which all elements, factors, organs or components are mutually related, knit together and self-controlled (Vikrant & Lajwanti, 2019). System analysis in education according to Moja (2000) and Khotambekovna (2021) is an analytical method used to study the problems and/or shortcomings of the educational system with a complex structural basis, which has a theoretical, methodological, scientific, philosophical, economic, social, political, spiritual and legal content. It is on the basis of system analysis that education stakeholders can explain the content of strategic issues in education.

Systems analysis believes in the entirety of education as a subsector of an economy. It considers teaching and training as social and technological process. In educational sphere, this approach arrive at solutions to education problems, and it helps to carry forward and

develop teaching and training system as per the new changes. Education is a system in which some elements function as input. Then these elements pass through a process and then emerge as output. The output is the product or the realization of objectives. This approach provides education with the level of active product system, and tries to establish education as a product.

Systems analysis is analogous to education production function. According to John (2010), education has a high-priority function in the production of human resources, and that the production function is a relationship between the amount of input and intervening factors to produce a certain good, with consideration to its quality. Education production function therefore represents a functional relationship between school and students inputs to an associated measure of school outputs. To ensure education production function adequately in addressing the demands of society, education policy makers, managers and other administrators must determine clear and precise objectives and select the inputs and strategies that will be transformed through the productive process into a qualified product.

The provision of quality education by upholding established education standards according to Ajibade (2019) and emphasized Mwangeka (2020) can be examined from the general systems perspective because education production function is a system of human resources, physical resources, methods, procedures and processes working together in a definite environment to deliver desirable outputs. Within the education system, non-conformities do occur and it imply deviations from the national set standards or norms. To locate where the problems occur can only be done through the education's system analysis.

Many reforms is being done in education today but the main thing is that all efforts should be focused on the development of education. System analysis is an approach used in diagnosing education

problem and prospects. It is one of the modern methodological principles of science and practice widely used in solving many theoretical and practical problems in education. The importance of taking a system analysis in addressing educational programme process is, education is an open system that allows for the best organization of the process based on innovation and knowledge, national and universal experience. An integrated approach involves taking into account the internal and external environment of the process (Khotambekovna, 2021). This means that in the process, it is necessary to take into account not only internal but also external factors like social, political, spiritual, educational, economic, geopolitical, demographic, environmental and other factors as likely impediment. These factors are important aspects in the analysis of modern education.

There is much active interest in the 21st Century in applications of systems analysis in education just as it is being used in other areas of endeavour. The stages of system analysis included formulation of a problem, construction of a model, discovery a solution, testing, evaluation, control, and implementation of the solution. The major aim of system analysis is to find the most efficient and economical methods to accomplish educational tasks.

However, system analysis involves studying the problem situation in education, identify its causes, and develop ways to solve it, make decisions and organize the subsequent operation of the system that can solve the problem situation. The first step in researching any system begins with identifying the object of analysis of the system. At this stage, tasks arise that radically separate the methodology of systematic analysis from the methodology of other disciplines. This, in turn, requires the development and implementation of measures for the education of harmoniously developed individuals in the field of education, the introduction of scientific and technological advances in the educational process, the training of world-class professionals,

the education system in line with national needs and interests requires improvement in performance.

The need for a system analysis in modern educational process is that it plays an important role in the development and consolidation of effective research methods in the field, as well as in their practical application. In knowing the learning process, its characteristics are a research method of practical importance in determining the level of importance for the development of society, predicting the future of each stage of education or managed subsystems that make up the system. It should be noted that in system analysis, is not only the system itself, but also its subsystems are studied as a whole. The need for a system analysis in education, plays an important role in identifying and analyzing the problems that are becoming increasingly relevant, the development of innovative methods of education and upbringing aimed at them. At the same time, as a result of system analysis, ideas are formed, which have a constructive character for the development of education. The education system has a special place in society in the self-organization of man, that is, in the self-education, preservation, protection, and, in general, in the ability of man to organize himself in every way. Every sane person lives his life in an interconnected way with the education system. It can be argued that the organization of man through education through self-conscious activity and noble goals depends only on himself (Ergasheva, n.d).

Relevance of System Analysis in Education

System analysis according to Sindhu (2012) provides scientific and quantitative bases for studying the problems of education and it have greatly influenced educational administration. The implication of system analysis in education include the following:

1. It helps in improving the implementation of education training programmes.

2. The subsystem of education is analyzed to understand the actual problem and tentative solutions can be verified to test on a segment of the system.
3. It brings to educational management practice a scientific-quantitative model for solving complex education administrative problems.
4. System analysis analyzes educational system objectively, empirically and economically.
5. It enables educational administrator identify the actual problem in education and abstains from a verified solution of the problem.

Criteria for Evaluation of System Analysis in Education

The general criteria of any evaluation in every system include performance evaluation, cost evaluation, utility evaluation and time evaluation since a system expected to operate in an optimal fashion. These criteria are discussed as follows:

1. *Performance evaluation:* If evaluation of education is based on performance the design of the problem solution should ascertain on how the new system will be effective in achieving the objectives.
2. *Cost evaluation:* This is an important criteria for the evaluating system analysis in education and it is influenced by cost function to a major extent. The amount of resources according to Sindhu (2012:41) is being put into the system function in terms of money, staff and facilities; comparison is made regarding the investment of resources in the new system of education.
3. *Utility evaluation:* Many educational functions require an assignment of a numerical utility. The return on investment represents the utility of a given function.
4. *Time evaluation:* Much of the contribution of the modern electronic data processing involves time in system analysis. Time factor is considered as an evaluation criterion in system

analysis in education and is closely associated with effective performance.

Summary

Education system is one of the most important elements of a social system consisting of different set of structural and functional related components (primary, secondary and tertiary level) that serve the purpose of educating and nurturing people effectively through planning, analysis, organizing and management. When education is systematically analyzed, the process first look at it as being complex comprising of integral, interconnected element (laws, Acts, ordinances, rules and essence). Systems analysis study procedures in order to identify goals and purposes that will efficiently achieve them. The ultimate goal of system analysis is to address a problem situation that has arisen in an organization, community, enterprise, individual region, social structure, etc. and apply it in solving problems.

Systems analysis considers teaching and training as social and technological process and because of the much interest in its application in education in the 21st Century, its stages include formulation of a problem, construction of a model, discovering a solution, testing, evaluation, control, and implementation of the solution. However, system analysis equally involves studying the problem situation in education, identification of causes and developing ways to solve it, make decisions and organize the subsequent operation of the system that can solve the problem. The need for a system analysis in modern educational process plays an important role in the development and consolidation of effective research methods in the field of educational administration and planning, as well as in their practical application in improving the implementation of education training programmes objectively, empirically and economically.

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Chapter **10**

INFORMATION SYSTEMS IN BUSINESS ORGANIZATIONS

Omenka Odoete Naomi
Department of Business Administration,
Ajayi Crowther University Oyo, Nigeria
Email: oin.omenka@acu.edu.ng

INTRODUCTION

In the contemporary business environment, information systems (IS) play a crucial role, acting as the backbone of organisational operations and decision-making processes. They are vital for the attainment of strategic goals and gaining competitive advantage. In essence, an information system is a coordinated system of hardware, software, data, people, and procedures designed to generate information that supports the activities of an organisation. It encompasses a wide range of technologies and methodologies that aid the gathering, processing, storing, and dissemination of information critical to business operations. Information system is to the business organisation what the blood is to the human system. These systems facilitate efficient management resources, enhance both internal and external communication, streamline business processes, facilitate data-driven decision-making, and support innovation and product development. Information technology (IT) refers to" any computer-based tool that people use to work information and support an organization's information and information processing needs" (Rainer & Prince, 2021).

IT has far-reaching effects on individuals and societies, organizations, the global economy and our planet. IT is a tool of globalisation, it

has made our world smaller, enabling more and more people to communicate, collaborate, and compete, thereby levelling the playing field and giving access to more players. An incredibly dynamic and rapidly evolving landscape is driving businesses towards constant innovation and adaptation. Policymakers are increasingly prioritizing the management of sustainability within a digitalized context, recognizing that integrating information technologies (IT) with sustainability goals presents numerous opportunities for beneficial transformation (Vidmar, Marolt &Andreja, 2021).

Over the years, the measurement of success of the information system (IS) has been researched with various studies on information system dimensions. DeLone and McLean (2003) have proposed a model that allows measuring the impact of information system on organizational performance. The study establishes that information system is relevant in the organization.

A system is a group of interconnected parts working together to achieve a specific goal. It transforms inputs into outputs. Similar to how data becomes information through a process, systems process inputs to create outputs. Complex systems often consist of multiple subsystems with individual goals that contribute to the overall objective. For instance, finance, operations, and marketing departments within an organization work together to achieve the company's broader goals. To function effectively, a system needs feedback to monitor its performance and control mechanisms to address issues and maintain its course. This framework includes five core components: input, process, output, feedback, and control (Derksen, & Luftman, 2013).

Information systems (IS) are designed to provide managers with information for decision-making and organisational control. To ensure effective control, organisations rely on control systems. While

open-loop systems lack feedback mechanisms and are impractical in complex business environments, closed-loop systems incorporate feedback to maintain control. **Feedback control** adjusts system actions based on the difference between desired and actual outputs. However, delays in this process can hinder effectiveness. **Feedforward control** predicts potential issues and proactively adjusts the system, reducing response time. While less common, feedforward control is valuable in certain situations, such as project management (Petter, DeLone, & McLean, 2008).

Valacich and Schneider (2010) emphasized that information systems are the combinations of hardware, software, and telecommunications networks that people build and use to collect, create, and distribute useful data, typically in organisational settings. Information systems play a vital role in today's business; it ultimately improves business processes, administration, and information management, leading to productivity and competitive advantage. Information systems involve the combination of human and material means in processing business information which have a relevant role to support and increase business efficiency and operational efficacy (Haag & Cummings, 2013). Thus, the success of business organization depends on the quality of information available for managers which are vital for decision making.

Information systems assist business managers to strategically position their business services to achieve the desired goal of the organization and provide necessary information for decision making. However, this dependence on information systems requires significant investments in technology, which can be challenging in uncertain economic conditions and intense global competition. Therefore, organizations need to assess the costs and benefits of these technologies to ensure profitable investments.

According to Laudon and Laudon (2012), an information system (IS) is a set of interrelated components that collect, process, store, and distribute information to support decision making and control in an organization. As such, information system is a vital tool for any corporate organization in any competitive market, where the efficient administration of data and information brings with it a competitive business advantage. In the contemporary business environment, the fact that the competitive market has provided the need for investment in Information Systems is non-debatable. However, empirical evidence points out that the investment in information system does not guarantee success in business (Pérez & Machado, 2015).

In today's digital age, a well-designed information system is crucial for any business seeking to secure its future. Such a system is essential for managing computer-related operations, achieving company objectives, and storing vital data, documents, and communication records. By automating data storage and retrieval, information systems save time and enhance efficiency. Moreover, they play a vital role in informed decision-making by providing easy access to vital information. Information systems also facilitate effective employee communication and collaboration by enabling easy sharing and access to stored documents. Overall, a robust information system is indispensable for businesses to streamline operations, enhance productivity, and drive success.

COMPONENTS OF INFORMATION SYSTEM (IS)

Information systems can be viewed as having six major components: hardware, software, network communications, data, people, and processes.

1. **Hardware:** The physical components of technology, such as computers, hard disks, and keyboards, have become faster and more storage-efficient while decreasing in cost. However, their environmental impact is a growing concern.

Cloud storage services offer an alternative, accessible via telecommunications networks.

2. **Software:** Software comes in two types: system software (operating systems like Microsoft Windows) that manages hardware and resources, and application software (like Microsoft Excel) designed for specific tasks. While system software makes hardware usable, application software handles particular tasks. Software can be proprietary, open-source, or custom-developed for large companies.
3. **Data:** A collection of facts. Data becomes powerful when organized and analyzed for business operations. Businesses collect and utilize data to make informed decisions and evaluate effectiveness.

Figure 1: Components of Information System

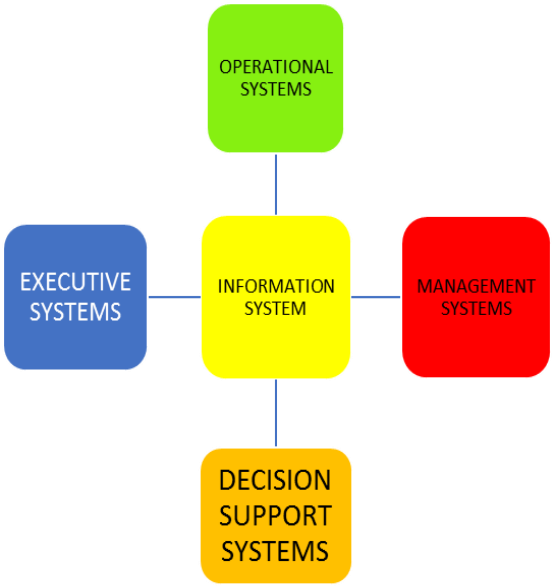
Source: Author's conceptualization 2024

4. **Network communications:** This connects computer systems or devices to share information via wired (fiber optics, coaxial cable) or wireless (radio waves, microwaves) networks, enabling communication and data exchange.
5. **People:** When examining information systems, it's essential to look beyond the technology itself and consider the people involved. This includes front-line support staff, systems analysts, developers, and the Chief Information Officer (CIO), all of whom play a crucial role.
6. **Process:** Additionally, the process component of information systems is vital. This refers to the series of steps taken to achieve a desired outcome or goal. Effective integration of technology with organizational processes can enhance productivity and control, but simply automating tasks is not enough. Businesses must strive to improve processes both internally and externally, streamlining interactions with suppliers and customers. This focus on process improvement is critical for gaining a competitive advantage, and concepts like business process re-engineering, management, and enterprise resource planning are all key to achieving this goal.

TYPES OF INFORMATION SYSTEMS

Businesses utilize various information systems to achieve their objectives, and the type of system used depends on their specific goals. There are four primary categories of information systems:

Figure 2: Types of Information System



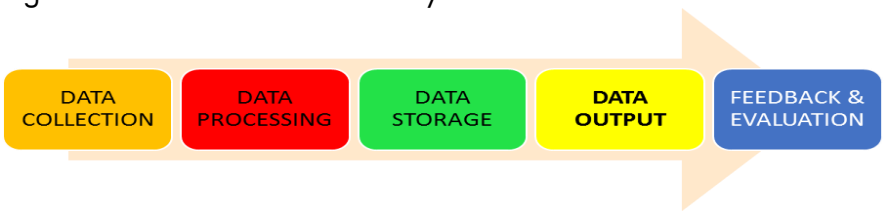
Source: Adopted Berisha-Namani, M., & Qehaja, A. (2013)

1. **Operational Systems:** These systems support specific business operations, such as transaction processing systems used in banking.
2. **Management Systems:** These systems integrate hardware and software to facilitate core business functions, gathering data from online systems for analysis and management support.
3. **Decision Support Systems:** These systems enable informed decision-making by analyzing rapidly changing information, and can be used in automated or human-operated systems, with optimal results from combined human-computer systems.
4. **Executive Systems:** Also known as Executive Support Systems, these systems aid senior-level decision-making, serving as a management support tool.

PROCESS OF INFORMATION SYSTEM IN BUSINESS ORGANISATION

To understand how Information Systems function in a business organization, it's essential to know the five key steps involved: (Laudon & Laudon, 2011).

Figure 3: Process of Information System



Source: Adapted

1. **Data Collection:** The first step is gathering data through various methods like voice, typing, or touchscreens, as well as using internal or external sensors to collect data from different sources.
2. **Data Processing:** The raw input data is processed by the Central Processing Unit (CPU) and transformed into a structured format using techniques like sorting, grouping, classification, and analysis.
3. **Data Storage:** The processed data is then stored temporarily or permanently in databases, data lakes, or data storage units, using physical devices like hard disks and Solid-State Drives (SSDs).
4. **Data Output:** The stored data is analyzed and presented in a suitable format using reports, dashboards, or data visualization tools.
5. **Feedback and Evaluation:** The final step involves collecting user feedback to assess the system's efficiency and understand user experience, enabling continuous improvement.

MANAGEMENT OF INFORMATION SYSTEM

The key measures for effective management of information systems are important to ensure their safe and efficient use, prevent data breaches, and maintain confidentiality. Some of the vital key measures to manage information systems include:

1. *Establishing Policies and Procedures*: Define clear guidelines for information system usage, data sharing, and implementation to ensure administrative control.
2. *Regular Auditing*: Monitor system access, data flow, and assess system efficiency through internal and external audits to ensure optimal performance.
3. *Operations Management:* Implement operational controls to protect sensitive data, including proper documentation, access limitations, and data archive management.
4. *Physical Protection*: Safeguard hardware and data centers through environmental controls, power management, and physical security measures.
5. *Identity Verification*: Ensure data security through secure coding practices, firewalls, and identity verification methods like biometrics (fingerprints, voice, or facial recognition).

IMPORTANCE OF INFORMATION TO BUSINESS ORGANIZATIONS

In today's digital age, information systems are seamlessly integrated into people's daily lives. People interact with them constantly through smartphones, laptops, and computers, utilizing them for various tasks such as messaging, online banking, e-commerce, and research. These systems serve as the foundation of modern businesses, providing unparalleled access to vast amounts of information and resources.

Information Systems (IS) are highly valuable in the management field, enabling decision-makers to make informed choices based on data from various databases. These systems use specific mechanisms to select, interpret, and process data, performing operations like sorting, selection, classification, and evaluation to organize information, reduce uncertainty, and propose solutions. IS are indispensable tools for modern businesses that support decision-making, streamline operations, enhance customer experiences, facilitate collaboration, drive strategic initiatives, and boost individual productivity. They are essential to drive innovation and efficiency of businesses of all sizes to succeed in a competitive market.

According to Wallace (2015), information systems play six key roles: decision making, operations, customer interaction, teamwork, strategic planning, and individual productivity.

1. **Decision Making:** Effective decision-making is crucial for businesses to succeed. Information systems generate data that helps managers understand their company's financial health, customer preferences, and overall performance. It empowers the managers to make informed choices about investments, marketing strategies, and resource allocation. For instance, analyzing sales data can reveal popular products, helping businesses focus their efforts accordingly.

2. **Operations Management:** In daily business operations, information systems help to manage employee records and payroll to tracking inventory and financial transactions, these systems enhance efficiency and accuracy. Information systems assist businesses to handle day-to-day activities such as money transfer services and other business activities smoothly.

3. **Customer Interactions:** The information system revolution has simplified how businesses interact with customers. ATMs, mobile recharges, and online bill payments are common examples of this.

For example, the rise of online shopping platforms demonstrates the growing impact of information systems on customer experiences.

4. **Collaboration:** Information systems have removed geographical barriers, thereby enabling seamless collaboration among teams and individuals irrespective of distances. Tools like Facebook, Skype and other social media platforms facilitate communication and connection on a global scene.

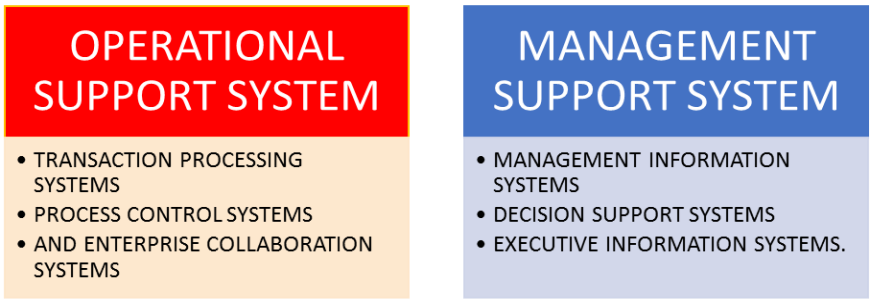
5. **Strategic Initiatives:** Information systems improve strategic business initiatives which can lead to a sustainable advantage. That is, leveraging data and technology in businesses can develop innovative strategies to gain a competitive advantage. For example, in a competitive market, offering unique services or reaching customers through new channels can help a company gain a sustainable competitive advantage.

6. **Individual Productivity:** Information systems can significantly enhance workers productivity when used effectively. Software applications like Excel and specialized tools can streamline tasks and enhance efficiency. However, it's crucial for employees to be proficient in using these tools to maximize their benefits.

APPLICATION AREAS OF INFORMATION SYSTEM IN BUSINESS ORGANIZATIONS

Information systems perform three vital roles in business organisations. Business applications of IS support an organization's business processes and operations, business decision-making, and strategic competitive advantage. Major application categories of information systems include operations support systems, such as transaction processing systems, process control systems, and enterprise collaboration systems, and management support systems, such as management information systems, decision support systems, and executive information systems.

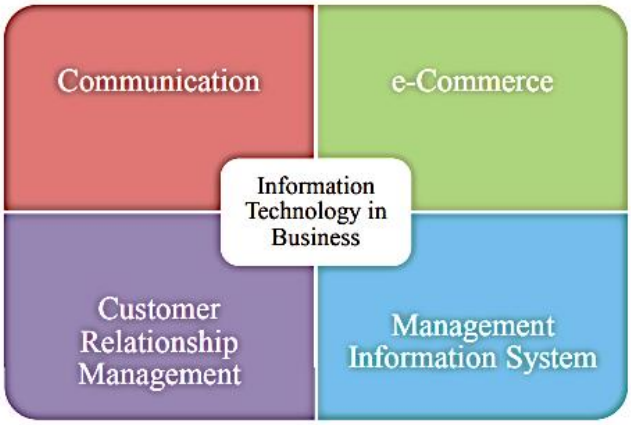
Figure 4: Applications of IS in Business Organisation



Source: Rai, Lang, & Walker, 2002

Information systems are essential tools for businesses, serving three primary functions: managing daily operations, aiding decision-making, and gaining a competitive edge. To fulfill these roles, organizations employ a variety of information systems, including those that support core business processes, facilitate management decisions, and provide strategic insights. While these systems can be categorized in different ways, in practice, they often overlap and work together to support an organization's overall goals (Rai, Lang, & Walker, 2002).

Figure 5: Application of Information Technology in Business



Source: Banerjee, 2015.

A. ***Communication*:** The integration of IT into business communication enhances clarity, consistency, effectiveness and efficiency and as a result, many business are opting for virtual management structures, advanced communication and IT tools. The convergence of communication and IT has transformed how we interact, creating a new era of digitally-connected communication. Information and communication technology (ICT) which has significantly reduced costs and expanded connectivity across organizational boundaries.

B. ***E-Commerce:*** In the contemporary, business has undergone significant changes globally, primarily driven by the increase in online shopping and the expansion of companies in the global scene. E-commerce, which involves buying and selling of products or services electronically, has become a pillar of modern business. Trust is essential for successful e-commerce; without it, online businesses risk failure. This new business model offers several advantages, including time savings through remote selling and automated processes. Additionally, e-commerce provides a direct channel for businesses to connect with customers.

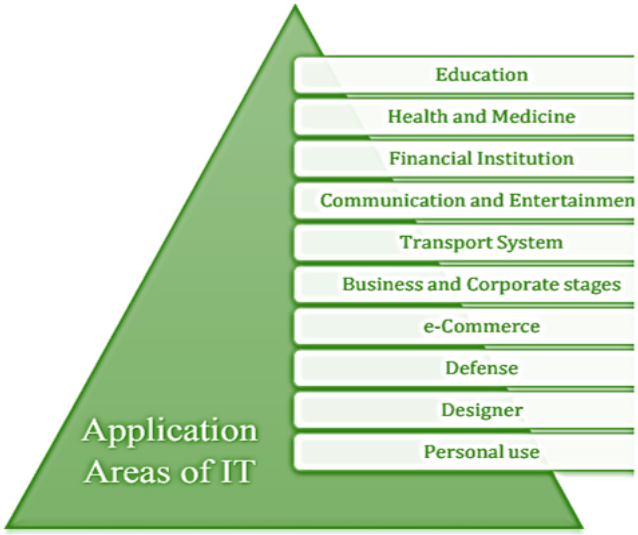
C. ***Customer Relationship Management***: Customer Relationship Management (CRM) is a strategic technology used to build and maintain strong relationships with customers. By gathering and analyzing customer data, CRM systems help businesses retain valuable clients and improve sales performance. These systems empower customers to interact with companies more efficiently while strengthening the overall customer-business bond. The popularity and study of CRM have surged in recent years, with research primarily focusing on the financial implications of CRM investments for businesses.

D. ***Management Information System***: Management Information System (MIS) is a tool that collects, organizes, and processes data to provide valuable information for managers. It aids in decision-making, performance evaluation, and internal communication. By optimizing data handling and analysis, MIS supports strategic planning and problem-solving within an organization. Essentially, MIS transforms raw data into actionable insights for effective management.

APPLICATION AREAS OF INFORMATION TECHNOLOGY

Digital technology has fundamentally transformed how we communicate in commerce, society, and government. By streamlining business processes, IT has significantly reduced operational costs. The economic advantages of using IT in business are substantial, offering cost-effective solutions. To fully understand these benefits, it's crucial to measure IT's impact on individual business units and the industry as a whole.

Figure 6: Application areas of Information Technology



Source: Banerjee, 2015

VARIOUS SOFTWARE USED IN BUSINESS ORGANIZATIONS

i. **Productivity software** refers to computer applications designed to help individuals and organizations work more efficiently and effectively. They encompass tools for creating, editing, and managing various types of documents, spreadsheets, presentations, and more. For example, Microsoft Office is a widely used productivity suite that includes several applications such as (i) Word: A word processor for creating and editing text documents, (ii) Excel: A spreadsheet application for data analysis and calculations; (iii) PowerPoint: A presentation software for creating visual aids; Outlook: An email and personal information manager; (iv) Access: A database management system for organizing and managing data.

ii. **Business intelligence software: Business Intelligence (BI)** software is essentially a tool that helps

organizations convert raw data into actionable insights. It involves collecting, storing, analyzing, and presenting data in a meaningful way to support better decision-making. BI software typically involves several components:

- **Data Collection:** Gathering data from various sources such as databases, spreadsheets, and external data feeds.
- **Data Storage:** Storing collected data in a centralized location, often a data warehouse or data mart.
- **Data Processing:** Cleaning, transforming, and organizing data for analysis.
- **Data Analysis:** Applying statistical and analytical techniques to uncover patterns, **Data Visualization:** Presenting findings in easy-to-understand formats like charts, graphs, and dashboards.

BENEFITS OF INFORMATION SYSTEM

Improved Decision Making: Provides data-driven insights to support informed choices. Information systems (IS) have revolutionized the way organizations make decisions from intuition-based to data-driven processes. Davenport and Prusak (1998) opine that information system can be managed strategically and exploited to gain sustainable competitive advantage. Keen and Scott Morton (1978) noted the ability of information system to access relevant data can provide a comprehensive view of the business environment, which is crucial for decision-makers to make proactive decisions. Davenport and Harris (2007) contend that, real-time analytics has become a critical competitive advantage that enable organizations to respond swiftly to changes in the market environment in today's dynamic business world. However, it is crucial to recognize that information systems have significantly enhanced decision-making capabilities and empowered organizations to make better decisions.

Enhanced Operational Efficiency: Information systems (IS) have become indispensable tools for corporate organizations seeking to enhance its operational efficiency. IS has transformed the way businesses operate. For example, routine tasks, such as data entry and inventory management, can be automated. Davenport and Prusak (1998) emphasized that since automation reduces operational costs, IS can significantly improve organizational productivity.

Competitive Advantage: Since Information systems (IS) enable the collection, storage, analysis, and dissemination of large data, it empowers business organisations to gain a competitive edge. In addition, IS facilitates product development and innovation. IS can be used in various dimensions to analyze market research data, customer feedback, and competitor information, providing organizations to identify ample opportunities for product improvement. Cooper (1993) emphasized that information about customer needs is crucial for successful product innovation.

Risk Management: Helps identify potential risks and develop mitigation strategies.

Increased Revenue: IS supports optimization of business operations that can drive sales growth. IS provide actionable intelligence needed to identify new business opportunities **that can** drive growth of the organization. In other words, application of IS in business is essential for revenue generation.

CASE STUDIES IN APPLICATION OF IT IN BUSINESS ORGANIZATIONS

In order to understand the strategies of application and implementation of IT in business organizations, there is a need to examine case studies that will provide invaluable insights into the

practical application of Information Technology (IT) within various business organizations.

Case Study 1: Uber

Before Uber's emergence, the traditional taxi or cab services especially in the developing countries like Nigeria, were faced with various challenges such as inconsistence in transport fare and unreliability had negatively impacted the user experience. Traditional taxi services were predominantly relying on physical cash payments, which posed serious security concerns for the passengers and sometimes resulted in disputes over change, particularly when it came to small denominations. These payment hassles left passengers to seek a more convenient and secure alternative for their mobility. This necessitated the rapid growth of Uber business in the transportation industry which can be attributed to its effective use of location-based services through mobile technology. The development of Uber apps which relies on the use of mobile payments, real-time data and GPS technology to connect riders with drivers has made mobility efficient.

Case Study 2: Amazon

The innovative use of IT in Amazon Company has undeniably proved its success over the years. Amazon employs data analytics and advanced algorithms to personalize the shopping experience, predict customer demand, and optimize its supply chain. Its IT was structured around a robust e-commerce platform, sophisticated warehouse management systems, and predictive analytics tools which has made Amazon achieve efficiency, enhanced customer satisfaction and drives significant revenue.

Case Study 3: Netflix

In the entertainment industry, Netflix has contributed significantly to the industry through its data-analytics approach to understand viewer preferences and behavior. This information is used for content

creation. Netflix harnessed the power of data to gain a sustainable competitive advantage, increased subscriber base, and redefined the media viewer's experience.

Case Study 4: Walmart

Walmart's dominance in retail is partly due to its efficient advanced inventory management systems, data analytics, and supply chain optimization software it employs through IT support. This has enabled Walmart to enjoy cost reductions, improved product availability, and enhanced customer satisfaction.

Summary

Information Systems (IS) serve as the foundation of business operations by supporting decision-making, resource allocation, communication, and overall efficiency. By incorporating hardware, software, data, networks, and human expertise, IS helps businesses optimize workflows, respond to market changes, and maintain a competitive advantage. Beyond operational efficiency, IS also fosters strategic growth by facilitating collaboration, enhancing customer engagement, and enabling data-driven insights. Different types of IS, including management information systems, decision support systems, and executive information systems, address various organizational requirements. Additionally, the expansion of e-commerce and customer relationship management systems underscores the growing significance of IS in shaping contemporary business strategies. Despite its many benefits, organizations must carefully evaluate their investments in IS to ensure they align with business goals and yield tangible results. As companies continue to embrace digital transformation, the effective management and integration of IS will remain essential for long-term sustainability, innovation, and success.

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Chapter 11

RESOURCES NEEDED IN AN INFORMATION SYSTEM

Helen Chibuogwu Enwezor
Faculty of Education
Department of Educational Foundations.
Chukwuemeka Odumegwu Ojukwu University. Igbariam.
Anambra state. Nigeria.
chiogewino@gmail.com

INTRODUCTION

Information systems are an integral part of modern organizations, playing a crucial role in the management and operation of business processes. These systems encompass a wide range of technologies, applications, and tools designed to collect, process, store, and distribute information. Information systems support decision-making, coordination, control, analysis, and visualization within an organization. They are essential for managing data, facilitating communication, and enabling efficient workflows. As businesses increasingly rely on digital technologies, the importance of robust and effective information systems cannot be overstated.

The development and implementation of information systems involve various components, including hardware, software, data, procedures, and people. Hardware comprises the physical devices necessary for information processing, while software includes the programs and applications that run on these devices. Data is the raw information that is processed and analyzed to generate insights. Procedures refer to the methods and rules for operating the system, and people are the users and IT professionals who interact with and manage the system. These components work together to ensure the

smooth functioning of information systems, enabling organizations to achieve their goals and objectives.

One of the critical aspects of an effective information system is the availability and utilization of resources. Resources in information systems include financial investments, technological infrastructure, skilled personnel, and access to data. Adequate financial investment ensures that an organization can acquire and maintain up-to-date technology and software. Technological infrastructure, such as servers, networks, and databases, provide the foundation for data processing and storage. Skilled personnel, including IT professionals and system users, are essential for designing, implementing, and maintaining the system. Access to high-quality and relevant data allows organizations to make informed decisions and gain a competitive edge. Without these resources, an information system cannot function optimally, potentially leading to inefficiencies and missed opportunities. Therefore, the importance of resources in the successful deployment and operation of information systems is paramount.

ESSENTIAL RESOURCES IN INFORMATION SYSTEM

Computers

Computers have profoundly transformed daily life and business practices, becoming essential tools for a multitude of tasks. Computers are originally designed for complex calculations and high-speed data processing. According to Reynolds (2020), computers have evolved into versatile devices supporting communication, entertainment, education, and business operations. They are foundational to information technology, driving advancements and efficiencies across various industries.

In the view of Olajide (2022), computers are essential resources in information systems, acting as the foundation for data processing,

storage, and management. They are integral to a wide range of applications, from personal productivity tools to sophisticated enterprise systems. As critical components of information systems, computers facilitate the execution of software programs that allow for the efficient retrieval, manipulation, and dissemination of data, making them indispensable in today's digital landscape. When it comes to information system there are particular components of computer that are very essential and considered to be prominent. This includes:

The types of computers: The types of computers used in information systems vary based on their capabilities and applications. Personal computers (PCs), including desktops and laptops, are widely used by individuals and small businesses for everyday tasks. Workstations, which are more powerful than PCs, are employed for tasks requiring higher performance, such as graphic design and scientific computations. Servers are pivotal in managing network resources and storing data, playing a crucial role in business operations and online services. Mainframes and supercomputers are used for large-scale computing tasks in sectors such as finance, weather forecasting, and scientific research, where processing vast amounts of data rapidly is essential (Laudon, 2022).

Sizes: Computers come in various sizes, each suited to different needs and environments. Smartphones and tablets represent the smaller end of the spectrum, offering portability and convenience for both personal and professional use. Laptops and desktops provide greater processing power and storage capacity, making them ideal for daily work and entertainment. Servers, typically housed in data centres, vary in size but are crucial for managing extensive data storage and processing. The largest computers, like mainframes and supercomputers, occupy entire rooms or buildings, reflecting their immense computational power and storage capabilities (O'Brien & Marakas, 2019).

Capacity: The capacity of computers, encompassing both processing power and storage, is a critical factor in their role within information systems. Processing power, often measured in gigahertz (GHz) or millions of instructions per second (MIPS), determines how quickly a computer can execute tasks. Storage capacity, measured in gigabytes (GB) or terabytes (TB), indicates how much data a computer can hold. High-capacity computers are vital for tasks involving large datasets or complex computations, ensuring that information systems operate efficiently and effectively (Stair, 2020).

***Input tools*:** Input tools are fundamental components that allow users to interact with computers. Keyboards and mice are the most common input devices, enabling users to enter data and navigate software applications. Touchscreens, increasingly common in mobile devices and some laptops, provide a direct and intuitive method for input. Specialized input devices, such as scanners and digital cameras, facilitate the digitization of physical documents and images, enabling their integration into digital information systems. These tools are crucial for ensuring accurate and efficient data entry (Laudon & Laudon, 2022).

Output tools: Output tools are equally important, enabling users to view and interpret the data processed by computers. Monitors and printers are primary output devices, displaying information visually or producing hard copies of digital documents. Speakers and headphones serve as output devices for audio data, essential for applications involving sound. Advanced output devices, such as virtual reality headsets, offer immersive experiences for gaming and simulation applications. These tools allow users to access and utilize the information generated by computers, making it actionable and useful (Ibezim, 2019).

Storage devices: Storage devices are vital for preserving data within information systems. Hard drives and solid-state drives (SSDs)

are the primary storage mediums for most computers, offering varying capacities and speeds. External storage devices, such as USB flash drives and external hard drives, provide additional space and portability for data. Network-attached storage (NAS) and cloud storage solutions offer scalable storage options accessible from multiple devices. These storage solutions ensure that data is safely stored and can be retrieved when needed, maintaining the integrity and availability of information within the system (Stair & Reynolds, 2020).

The roles of computers in information systems extend beyond basic data processing and storage. They enable the automation of routine tasks, enhancing productivity and reducing the potential for human error. Computers support complex decision-making processes through data analysis and visualization tools, providing insights that drive business strategies. They facilitate communication and collaboration through networked systems and internet connectivity, enabling seamless interaction across geographical boundaries. Additionally, computers support the development and deployment of software applications tailored to specific organizational needs (Ahmed, 2008).

Automation

Automation is a crucial resource in information systems, driving efficiency and reducing the need for manual intervention in repetitive tasks. By leveraging automation, organizations can streamline their processes, enhance productivity, and minimize the risk of human error. Automation enables the smooth operation of complex information systems, ensuring that tasks are performed consistently and accurately. This not only saves time and resources but also allows employees to focus on more strategic and value-added activities, thus contributing to overall organizational effectiveness (Delen, 2014).

In information system, different types of software, programming languages and tools; internet and its protocols are the basic factors

that enable the achievement of automation. They are discussed below:

Different types of software: Different types of software are essential for implementing automation in information systems. Enterprise Resource Planning (ERP) software, such as SAP and Oracle, integrates various business processes, allowing for seamless data flow and process automation across departments. Customer Relationship Management (CRM) software, like Salesforce, automates customer-related processes, improving service efficiency and client management. Additionally, Robotic Process Automation (RPA) tools, such as UiPath and Automation Anywhere, enable the automation of routine tasks by mimicking human actions. These software solutions are vital for creating efficient and automated information systems (Udoka, 2022).

Programming languages: Programming languages play a significant role in developing automation solutions for information systems. Languages such as Python, Java, and C# are commonly used to write scripts and develop applications that automate tasks. Python is particularly popular due to its simplicity and extensive libraries for automation and data manipulation. Java is widely used in enterprise environments for building robust and scalable automation solutions. C# is preferred for developing Windows-based applications and automation tools. These programming languages provide the necessary capabilities to create customized automation solutions tailored to specific organizational needs (Sebesta, 2016).

Tools: Various tools are necessary for effective automation in information systems. Integrated Development Environments (IDEs) like Visual Studio and PyCharm facilitate the development of automation scripts and applications. Continuous Integration/Continuous Deployment (CI/CD) tools, such as Jenkins and GitLab, automate the software development lifecycle, ensuring that code changes are

tested and deployed efficiently. Monitoring and logging tools, like Splunk and Nagios, automate the monitoring of system performance and logs, providing real-time insights and alerts. These tools are essential for developing, deploying, and maintaining automated information systems (Stallings, 2018).

Internet and its protocols: The internet and its protocols are fundamental for enabling automation in information systems. Hypertext Transfer Protocol (HTTP) and its secure version, HTTPS, are crucial for automating web-based interactions and data exchange. Simple Mail Transfer Protocol (SMTP) and Internet Message Access Protocol (IMAP) are used for automating email communications. File Transfer Protocol (FTP) and its secure variant, SFTP, facilitate automated file transfers. These protocols enable seamless communication and data transfer between systems, supporting the automation of various processes within information systems (Ross, 2021).

Automation in information systems also significantly impacts data management and analytics. Automated data collection tools streamline the gathering of data from various sources, ensuring that information is accurate and up-to-date. Data integration platforms, such as Apache Kafka and Talend, automate the consolidation of data from disparate systems, providing a unified view of organizational information. Automated analytical tools like Tableau and Power BI, enable real-time data analysis and visualization, offering insights that drive informed decision-making. By automating these processes, organizations can handle large volumes of data more effectively, leading to better business outcomes (Wamba et al., 2015). In addition to improving data management, automation enhances cybersecurity within information systems. Automated security tools, such as firewalls, intrusion detection systems (IDS), and antivirus software, continuously monitor systems for threats and respond to incidents in real-time. Security Information and Event

Management (SIEM) systems, like Splunk and IBM QRadar, automate the collection, analysis, and correlation of security data, helping organizations detect and mitigate potential threats quickly. Automation in cybersecurity ensures that systems are protected around the clock, reducing the risk of data breaches and cyber-attacks (Mattord, 2021).

The role of automation extends to customer service and support as well. Automated customer service tools, such as chatbots and virtual assistants, provide instant responses to customer inquiries, improving service efficiency and satisfaction. These tools leverage natural language processing (NLP) and machine learning algorithms to understand and respond to customer queries accurately. Automated ticketing systems streamline the management of support requests, ensuring that issues are tracked and resolved promptly. By automating customer service processes, organizations can enhance their responsiveness and maintain high levels of customer satisfaction (Huang, 2014).

Telecommunication

Telecommunication plays a pivotal role in the realm of Information Systems, serving as the backbone that facilitates the exchange of data and information across various platforms. It encompasses the transmission of data over significant distances, enabling communication between individuals, businesses, and devices globally (Stallings, 2016). The integration of telecommunication in information systems enhances the efficiency and effectiveness of operations, fostering a connected environment that supports the real-time exchange of information. This connectivity is essential for the smooth functioning of modern businesses and organizations, where the rapid transmission of data is a crucial requirement (FitzGerald & Dennis, 2014). The aspects of communication that are very essential for Information Systems includes:

Networking: Networking is a fundamental aspect of telecommunication within Information Systems. It involves the interconnection of various devices, such as computers, servers, and mobile devices, to facilitate communication and data exchange (Tanebaum & Wetherall, 2010). Networks can be classified into different types based on their size, range, and purpose. The primary function of networking is to enable resource sharing, improve communication, and ensure the seamless flow of information across the organization. Effective networking can significantly enhance productivity, streamline operations, and reduce costs by enabling shared access to resources and information (Kurose, 2017).

Types of networks: Types of networks include Local Area Networks (LANs), Wide Area Networks (WANs), and Metropolitan Area Networks (MANs) (Forouzan, 2012). LANs cover a small geographic area, typically within a single building or campus, providing high-speed connectivity for local devices. WANs, on the other hand, span large geographic areas, connecting multiple LANs across cities, countries, or even continents, often using leased telecommunication lines. MANs serve as intermediaries, covering larger areas than LANs but smaller than WANs, usually within a city or a large campus. Each network type serves specific purposes and is chosen based on the organization's requirements, ensuring efficient and reliable communication and data transfer (Panko, 2013).

Network topologies: Network topologies refer to the arrangement of different elements (links, nodes, etc.) in a computer network. Common topologies include bus, star, ring, mesh, and hybrid (Perlman, 2000). The choice of topology affects the network's performance, scalability, and fault tolerance. For instance, a star topology, where each node is connected to a central hub, offers easy troubleshooting and centralized management but can be prone to single points of failure. Mesh topology, where nodes are interconnected, provides high fault tolerance and redundancy,

ensuring reliable communication even if one link fails. The selection of an appropriate topology is crucial for optimizing network performance and reliability (Olifer, 2006).

Data transmission: Data transmission is a critical component of telecommunication, involving the transfer of data between devices through various transmission mediums such as cables, optical fibers, and wireless signals (Forouzan, 2013). The speed and efficiency of data transmission are influenced by factors like bandwidth, latency, and transmission protocols. Advanced transmission technologies, such as 5G, fiber optics, and satellite communication, have revolutionized the way data is transmitted, offering higher speeds, lower latency, and greater reliability. Effective data transmission is essential for supporting high-demand applications, enabling real-time communication, and ensuring the seamless flow of information across networks (Tomasi, 2004).

Telecommunication devices are integral to the functioning of information systems. These include routers, switches, modems, and gateways, which facilitate the routing, switching, and transmission of data across networks (Kurose & Ross, 2017). Routers direct data packets between different networks, switches connect multiple devices within a LAN, modems modulate and demodulate signals for transmission over telephone lines, and gateways serve as points of entry and exit between different networks. These devices play a crucial role in maintaining network connectivity, ensuring data integrity, and enabling efficient communication. The continuous evolution of telecommunication technology drives the development of more advanced and efficient devices, further enhancing the capabilities of information systems (Oluh, 2016).

The roles of telecommunication in information systems extend beyond mere connectivity. Telecommunication technologies enable the integration of various information system components, facilitating

unified communication and data management. This integration supports business processes such as remote work, video conferencing, cloud computing, and e-commerce, making operations more flexible and adaptive to changing environments (Dennis, 2014). Moreover, telecommunication supports disaster recovery and business continuity by providing alternative communication channels and data backup solutions, ensuring that organizations can maintain operations during and after unforeseen disruptions (Gbenga, 2012).

Database

Databases are a fundamental component of Information Systems, providing a structured environment for storing, managing, and retrieving data. They enable organizations to efficiently handle vast amounts of information, ensuring data consistency, accuracy, and security. In the context of Information Systems, databases support various applications, from transaction processing to business intelligence, facilitating decision-making and operational processes. The role of databases extends beyond mere data storage, encompassing complex functionalities that enhance the overall efficiency and effectiveness of Information Systems (Elmasri & Navathe, 2016). For Information Systems, the major considerations in database are:

Data hierarchy: The data hierarchy is a critical component in database management, organizing data into levels of granularity. At the base of this hierarchy are bits and bytes, which form characters, the smallest data units. These characters combine to create fields, representing specific data attributes, which are then grouped into records, each containing related fields. Records are organized into files or tables, which collectively form databases. This hierarchical structure ensures that data is systematically organized, making it easier to store, retrieve, and manage (Topi, 2013). Understanding the data hierarchy is essential for designing efficient databases that support the needs of an Information System.

Database structures: Database structures refer to the ways in which data is logically organized within a database. Common structures include hierarchical, network, relational, and object-oriented models. The relational model, which organizes data into tables with rows and columns, is the most widely used due to its simplicity and flexibility. It allows for easy data manipulation using Structured Query Language (SQL). Hierarchical and network models, though less common, are still used in specific applications requiring complex data relationships. Object-oriented databases, which store data as objects, are particularly useful in environments that require the integration of complex data types and behaviors. Each structure has its advantages and is chosen based on the specific needs and requirements of the organization (Connolly & Begg, 2015).

Database Management System: A Database Management System (DBMS) is software that provides tools for creating, updating, managing, and querying databases. It ensures data integrity, security, and consistency, offering functionalities such as transaction management, concurrency control, and backup and recovery. Popular DBMSs include Oracle, MySQL, Microsoft SQL Server, and PostgreSQL, each providing robust features for managing large-scale databases. The role of a DBMS in an Information System is to facilitate efficient data handling, support complex queries, and ensure that data remains accurate and accessible at all times (Silberschatz, 2010).

Database administrators: Database administrators (DBAs) and other IT professionals play vital roles in managing and maintaining databases within an Information System. DBAs are responsible for installing, configuring, and upgrading DBMS software, ensuring database security, performing backups, and optimizing performance. They work closely with system administrators, network engineers, and application developers to ensure that databases support the overall IT infrastructure and business applications. Their

expertise is crucial for maintaining the health and efficiency of databases, addressing issues promptly, and implementing best practices for database management (Rob, 2017).

IT professionals: In addition to DBAs, other IT professionals, such as data analysts, database developers, and IT managers, contribute to the effective utilization of databases in Information Systems. Data analysts use databases to extract insights and generate reports, aiding in strategic decision-making. Database developers design and implement database structures, write SQL queries, and develop applications that interact with databases. IT managers oversee database projects, ensuring alignment with business objectives and managing resources effectively. The collaboration among these professionals ensures that databases are well-designed, maintained, and utilized, maximizing their value to the organization (Marakas, 2011).

The evolution of database technologies continues to shape the landscape of Information Systems. With the advent of big data and the growing importance of data analytics, organizations are increasingly leveraging advanced database solutions to manage and analyze large volumes of data. NoSQL databases, for instance, offer flexible schema designs that cater to the needs of modern applications, allowing for the efficient handling of unstructured and semi-structured data (Pokorny, 2013). These databases complement traditional relational databases, providing scalable and high-performance options for specific use cases such as real-time data processing and large-scale distributed systems.

People/Human Resource

People are a fundamental resource in any Information System (IS), playing crucial roles in the development, implementation, and maintenance of these systems. The human component ensures that the technological infrastructure is utilized effectively to meet

organizational goals. This aspect encompasses a broad range of participants, from top-level management to everyday end users, each contributing uniquely to the system's success. Understanding the roles and importance of these various participants can provide insight into how Information Systems are designed, operated, and improved upon continuously. For achieving good information system the people needed are the IT specialists and end-users.

IT specialists: IT specialists are central to the operation and maintenance of Information Systems. These professionals include systems analysts, software developers, network administrators, and security experts. Systems analysts bridge the gap between business requirements and technology solutions, ensuring that the systems align with organizational objectives (Anameje, 2022). Software developers create the applications and programs that allow users to perform tasks efficiently, while network administrators ensure that the communication infrastructure is robust and reliable. Security experts protect the system from cyber threats, ensuring data integrity and confidentiality. Together, these IT specialists ensure that the Information System is functional, secure, and adaptable to changing needs.

End users: End users are the individuals who interact with the Information System daily. They range from clerical staff who input data to executives who use the system for decision-making purposes. Their feedback is vital for the continuous improvement of the system, as they provide insights into usability and functionality issues that may not be apparent to IT specialists (Hall, 2019). Effective training and support for end users are crucial, as their proficiency with the system directly impacts productivity and accuracy. End users ensure that the data entered into the system is accurate and up-to-date, which is essential for generating reliable information and reports.

Top management also plays a significant role in the success of an Information System. Their involvement is crucial in strategic planning, decision-making, and resource allocation. They provide the vision and direction for the development and implementation of the system, ensuring that it aligns with the overall business strategy (Galletta, 2020). Without the support and commitment of top management, it is challenging to secure the necessary resources and foster a culture that embraces technological change. They also play a key role in managing resistance to change and ensuring that the benefits of the Information System are communicated throughout the organization.
Support staff, such as help desk technicians and trainers, are essential for the smooth operation of Information Systems. Help desk technicians provide immediate assistance to users encountering technical issues, minimizing downtime and maintaining productivity (Stair & Reynolds, 2021). Trainers ensure that employees are proficient in using the system, offering both initial training sessions and ongoing learning opportunities to keep skills current. These support roles are critical in ensuring that the Information System operates efficiently and that users can leverage its full potential.

Additionally, project managers are another crucial group of people involved in Information Systems. They are responsible for planning, executing, and closing projects that relate to the development and enhancement of these systems. Project managers coordinate the efforts of various teams, ensuring that projects stay on schedule and within budget. They are skilled in risk management and problem-solving, which are essential for navigating the complexities of system implementation and upgrades (Schwalbe, 2021). Their role involves constant communication with stakeholders to ensure that project objectives are aligned with business needs and that any issues are addressed promptly. Project managers help in translating strategic visions into practical, executable plans, thereby bridging the gap between high-level goals and technical execution.

Another essential role is played by data scientists and analysts, who focus on extracting actionable insights from the vast amounts of data generated by Information Systems. These professionals use statistical methods and advanced analytics to interpret data trends and patterns, which can inform business decisions and strategies. They work closely with IT specialists to ensure that the data infrastructure supports analytical processes and that data quality is maintained (Fawcett, 2013). By transforming raw data into meaningful information, data scientists and analysts provide a competitive edge to organizations, enabling them to make data-driven decisions and innovate effectively. Their expertise is particularly valuable in fields such as customer relationship management, market analysis, and operational efficiency.

People are indispensable to the success of Information Systems. The combined efforts of IT specialists, end users, top management, and support staff ensure that these systems are well-designed, effectively implemented, and continuously improved. Each group plays a distinct yet interdependent role, contributing to a cohesive and efficient Information System that supports the organization's objectives and enhances its operational capabilities.

Procedures, Policies, Regulations, and Rules

Procedures, policies, regulations, and rules are crucial components in the management and operation of Information Systems (IS). They provide a structured framework that ensures consistency, security, and efficiency in the handling of data and technology resources. These elements help organizations to mitigate risks, comply with legal and ethical standards, and achieve their strategic objectives. By establishing clear guidelines, procedures, policies, regulations, and rules support the effective use and management of IS, contributing to overall organizational success.

Procedures in Information Systems outline the specific steps and methods that must be followed to perform tasks effectively. They ensure that operations are carried out consistently and efficiently, reducing the likelihood of errors and enhancing productivity (O'Brien & Marakas, 2019). Procedures also facilitate training and onboarding of new employees by providing a clear, documented process for various activities. In times of system failure or crisis, having well-defined procedures can help in quick recovery and continuity of operations, minimizing downtime and its associated costs.

Policies play a critical role in guiding the behavior and decisions of individuals within the organization. They establish the framework within which Information Systems operate, ensuring that all activities align with the organization's goals and values. For example, a data privacy policy outlines how personal information should be handled, protecting the organization from legal repercussions and maintaining customer trust (Laudon & Laudon, 2022). Policies also help in standardizing operations across different departments, fostering a cohesive and coordinated approach to managing Information Systems.

Regulations are external requirements imposed by governmental or industry bodies that organizations must comply with to operate legally and ethically. In the context of Information Systems, regulations such as the General Data Protection Regulation (GDPR) or the Health Insurance Portability and Accountability Act (HIPAA) dictate how data must be collected, stored, and processed (Pearlson, 2020). Compliance with these regulations is essential to avoid legal penalties and protect the organization's reputation. Adhering to regulations also promotes a culture of accountability and responsibility within the organization.

Rules are specific, detailed directives that govern the operation of Information Systems. They include access controls, data management

protocols, and security measures designed to protect the integrity and confidentiality of information. For instance, access control rules determine who can view or edit certain data, ensuring that only authorized personnel have access to sensitive information (Stair & Reynolds, 2021). These rules help in preventing unauthorized access, data breaches, and other security incidents that could compromise the organization's assets and operations.

The importance of having clear and well-communicated procedures, policies, regulations, and rules cannot be overstated. They provide a foundation for the reliable and secure operation of Information Systems, enabling organizations to achieve their objectives while managing risks effectively. By promoting consistency, accountability, and compliance, these elements ensure that Information Systems are used responsibly and effectively, supporting both the technical and strategic needs of the organization. Procedures, policies, regulations, and rules are integral to the effective management of Information Systems. They offer a structured approach to handling data and technology resources, ensuring that operations are consistent, secure, and aligned with organizational goals. Each component plays a distinct role in guiding behavior, ensuring compliance, and protecting the organization from risks. Together, they form a comprehensive framework that supports the successful implementation and operation of Information Systems, ultimately contributing to the organization's overall success and sustainability.

SUMMARY

The resources needed for an information system encompass a broad range of components that collectively enable the effective management and processing of information within an organization. These resources include hardware, software, data, personnel, and procedures. Hardware resources comprise computers, servers, networking devices, and storage systems, which form the physical foundation of the information system. Software resources, including

operating systems, application software, and database management systems, facilitate the execution of tasks and the management of data. Data is the core resource, as it provides the necessary information for decision-making and operations.

Personnel, such as IT professionals, database administrators, and system analysts, play a critical role in developing, maintaining, and managing information systems. Their expertise ensures the system operates efficiently and securely, addressing any technical issues that arise. Procedures and protocols guide the use and management of the information system, ensuring consistency, security, and compliance with regulations. Together, these resources create a robust framework that supports the organization's information needs, enabling seamless communication, data processing, and decision-making.

In the modern digital landscape, the integration of advanced technologies such as cloud computing, artificial intelligence, and big data analytics further enhances the capabilities of information systems. Cloud computing provides scalable and flexible access to resources, reducing the need for extensive on-premises infrastructure. AI and machine learning enable predictive analytics and automation, driving innovation and operational efficiency. The continuous evolution of these technologies, combined with the foundational resources of hardware, software, data, personnel, and procedures, ensures that information systems remain pivotal in supporting organizational goals and adapting to dynamic business environments.

Chapter **12**

INFORMATION SYSYEM DEVELOPMENT AND ACQUISITION

Olusegun Samuel Olaniyi, PhD &
Oluwatosin Adewale Alabi
Department of Educational Management
College of Specialised and Professional Education
Tai Solarin University of Education, Ijagun, Ogun State, Nigeria
Correspondence Email: olaniyios@tasued.edu.ng
Mobile Phone: +2348052472953

INTRODUCTION

Information is the core of life to organizations. It can be put to the best use if it is valid, reliable, timely, fit for purpose, accessible, cost effective, accurate, relevant and understandable by the users, in terms of quality. The relevance of information to organization cannot be overemphasized. This is why organizations are now becoming information-driven and are shifting attentions from processing data to requiring information for management's decisions. Good quality and valid information is therefore critical for organizations to make informed decisions and take effective actions towards achieving set goals. In today's digital age, developing a system to handle vast amount of data and information is key to helping organizations improve their efficiency.

In the realm of organizational operations, the development and acquisition of information systems are vital components that actually influence an organization's system framework and performance. Adequate information handled by information system provides decision-makers and stakeholders with the necessary understanding

and dimensions to effectively manage the activities and procedures associated with information system development and acquisition. The major functions of information systems include; data input and capturing, data processing and analysis, data storage and retrieval, decision making and problem solving, information output and dissemination, data maintenance, and data security and protection. These functions work together to ensure that data is acquired, processed, stored, and presented in a manner that suits organization's needs.

In this modern age, the ability to create and procure efficient information systems is sine qua non to organizations seeking success in most efficient form. This fact is established through an excerpt from the article by the University of Scranton (a Jasuit University) which narrates that:

> *In the past when a company received a customer order, whether it was for a service requested or for a product Purchased, the order needed to go through a process of paper-based workflow that was passed along to different departments, inbox-to-inbox. Through this process, the order often had to be re-typed as it passed through various departments, increasing the potential for human error. …But today, companies have eliminated the inaccuracy of paper-based tracking for the computer-based tracking system…*

Information Systems Concept

An Information system (that is, the computer software that can help run the organization's business) has two primary functions: 1) to provide the operational features for day-to-day activities and 2) to support an organization by providing essential information to managers (McKee, 2022). Information systems play a pivotal role in modern organizations, as information acquisition may seem to be slow, but when such information is needed urgently, the decision to use information system is non-negotiable.

According to Strauss (2022), information systems encompass the tools that organizations use to collect, manage, and analyze data. Also, information systems are collections of multiple information resources to gather, process, store, and disseminate information. Such tools needed for the information processing are laptops, databases, network, and smartphones. Also, Mukherjee (2024) defines information systems as a combination of software, hardware, and telecommunication networks to collect useful data, especially in an organization. TechTarget contributor (2023) defines an information system as an interconnected set of components used to collect, store, process and transmit data and digital information. This is why people often use the term "information system" interchangeably with "computer system".

A computer information system or computer system is a system that is composed of people and computers that processes or interprets information. Information systems is also an academic field of study about systems with a specific reference to information and the complementary networks of computer hardware and software that people and organizations use to collect, filter, process, create and also distribute data. These systems facilitate efficient operations, decision-making, and strategic planning for the attainment of goals as planned. They play a significant role in providing essential data and tools for decision makers to make relevant and very crucial decisions in efficient manner. The development and acquisition of information systems involve various key concepts, challenges, and best practices that organizations need to navigate their challenges effectively. In today's fast-paced business environment, organizations must align their information systems with their business objectives and technological capabilities to drive innovation and growth. The rapid evolution of technology, coupled with modern customer demands and increasing competition, lays emphasis on the significance of strategic decision-making in information management environment.

According to Sharma (n.d.), there are six major types of information systems:

1. *Transaction processing system (TPS),* which is a system that helps day-to-day business operations;
2. *Office automation system (OAS) or office information system (OIS),* an information system that uses computer hardware, software, and networks to enhance workflow and as well facilitate communications among office workers. It helps in handling office tasks such as sending messages via email and voicemail, typesetting using word-processing packages, and so on;
3. *Knowledge work system/Expert system* are programs that help the computer make decisions in a similar way as an expert in specific domains or in subject area of interest. They are used for the medical diagnosis, accounting and finance, marketing, manufacturing and in assessment of project proposal ensures technical skills and knowledge are applied correctly (examples are computer-aided design system, financial work stations, and virtual reality;
4. *Management information systems (MIS)* which are used by the middle managers to handle administrative activities of day-to-day routines and performance and monitoring;
5. *Decision support system (DSS) - it* is an interactive computer-based information system for helping managers to make decisions; and
6. *Executive support system (ESS)* – it is a system that supports executive-level decision making, especially when handling company matters.

Also, the information systems (or computer systems) components include: 1) *Hardware*-which are the physical components of the technology used to manage data such as smartphones, computers, and their parts; 2) *Software* that consist of system software and application software are the intangible materials or programmes that direct the hardware to perform specific tasks; 3) *Data sources* that house data that can be retrieved, manipulated, and

analyzed to make decisions, such as databases and data warehouses; 4) *Telecommunication* itself is used to connect with the computer system or other devices to disseminate information; 5) *Human* or people is a component that makes use of all forms of information systems, also known as human-ware.

The common steps in any information system include: 1) *Input phase*- this is the process by which the system collects data through various ways such as by typing, voice note, or touchscreens in the use of smartphones; 2) *Processing Phase*-it is the process of converting data collected into a structured format; 3) *Storage Phase*-it is the process of keeping or storing data either temporarily or permanently through the use of physical and non-physical storage media; 4) *Output phase*-This is the process of visualizing processed data either in softcopy or hardcopy. It shows the report about the processed data; 5) *Feedback*-this allows individuals to assess the system's efficiency (TechTarget Contributor, 2023). This process is often called *data processing cycle.*

Life Cycle of Information Systems

There are four main phases in a lifecycle of an information system. They are: 1) Information systems development, 2) Information systems in use (operation), 3) Information systems maintenance management, and 4) Information systems withdrawal

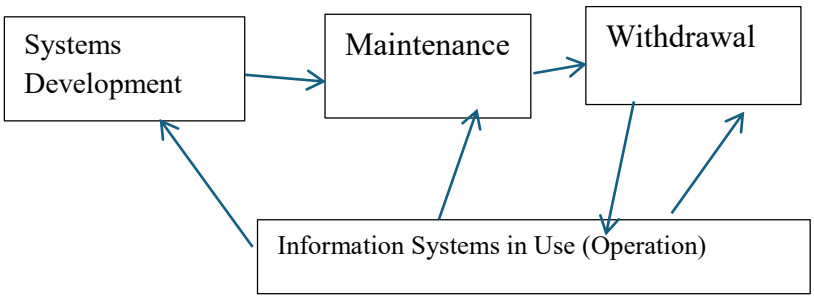

Figure 1: Information Life Cycle
Source: Laudon (2019)

Information systems in use could need an upgrading. This is referred to as system development. After developing a system, there is the need for periodic follow-up for maintenance. In case, the new system developed is malfunctioning; it can then be withdrawn for a new system.

INFORMATION SYSTEM DEVELOPMENT

A system development is the process of defining, designing, testing, and implementing a new software application or program. It is also defined as a set of activities, methods, best practices, deliverables, and automated tools that stakeholders use to develop and maintain. It can be defined as the process by which some collective work activity is facilitated by new information-technological means through analysis, design, implementation, introduction and sustained support, as well as process management. The system development life cycle covers: 1) *Preliminary analysis*, where a request for a replacement or new system is first reviewed. This also involves feasibility studies including technical feasibility, economic feasibility, and legal feasibility; 2) *System analysis* is where the system manager determines the specific requirements for the new system; 3) *System design* is where the system designer takes over other activities from the system analyst and develop specific technical required for the

system; 4) *programming*- it is a stage where code finally gets written in the programming phase; 5) *Testing*, which is an activity of performing Unit test, System test and user-acceptance test. If errors are detected, they are resolved accordingly; 6) *Implementation*- is a stage where users are trained while providing documentation and data conversion from the previous system to the new system; 7) Maintenance-this stage permits fixing of problems encountered in system development, system updates and backup activities are carried out. Figure 2 shows the information system lifecycle.

The analysis of any organizational activity can lead to different outcomes, such as:
Information development, unit development, status quo (current situation is sufficiently good liquidation (of activities that are obsolete). It is the system analysis that would dictate whether there is the need for system development or not. The idea of finding a way to develop an information system will require an approach to system acquisition.

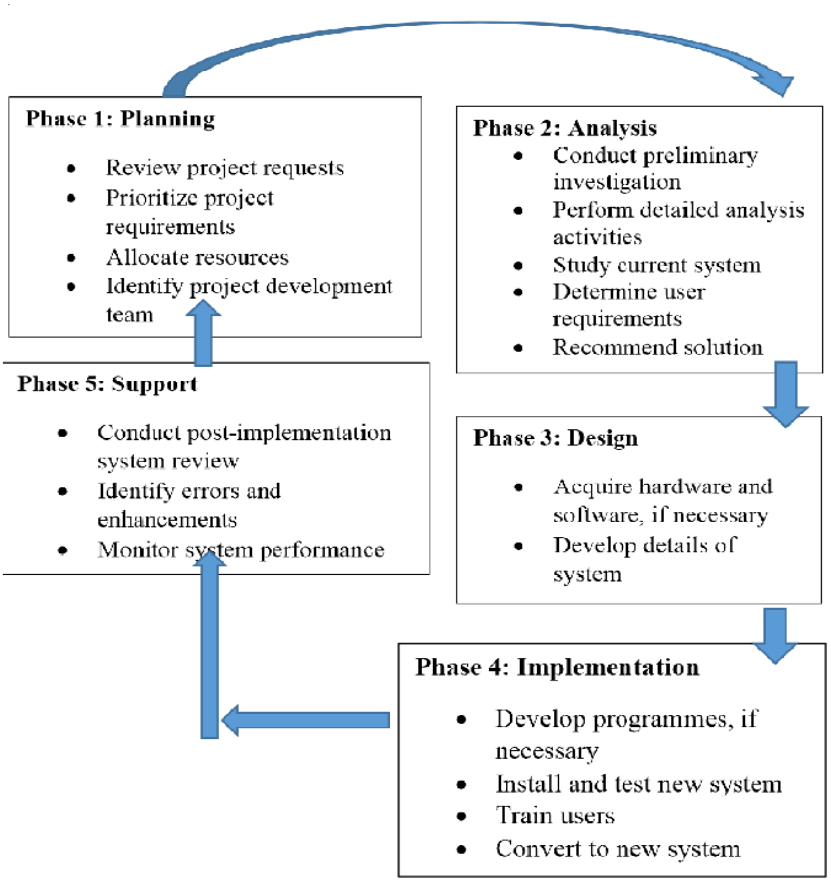

Figure 2: Information System Development Life Cycle
Source: Adapted, Ahmad (2015)

INFORMATION SYSTEM ACQUISITION

An information system acquisition process usually begins with user identifying the needs for information systems. The users' demand determines the type of information systems to be procured and supplied. Basically, information system acquisition is the process of obtaining an information system for an organization. The various methods of acquiring information system are discussed as follows:

1. *Purchasing:* This is the direct purchase of a pre-written application used by more than one company. Systems can be acquired through purchasing order (PO).
2. *Bespoke development (building):* This is a method to by which information system is uniquely designed and tailored to meet user's needs. There are three major options to in-house development, namely; building right from beginning, in-house development (insourcing), and end-user development.
3. *Leasing:* This method allows an organization (lessor) to enter into a financial agreement with another organization (lessee) to pay for the use of their information system for a particular period of time.
4. *Outsourcing:* This is the process of engaging a third party individual or organization outside the organization, either locally or internationally to handle certain organization's activities that are beyond the capacity of the existing resources.
5. *Development:* This is a process whereby a systems specialist develops an information system to improve an existing system or develop a new system based on user's requirements.
6. *Request for quotations:* This is a procurement method used for goods and services. In this case, the procurement entity selects a minimum of three suppliers that they wish to get quotations from. A comparison of quotations is done through proper analysis, while the best quotation is chosen based on meeting up with the requirements and specifications.

Bidding Process of External Acquisition of Information Systems

According to Bartleby (n.d.), **t**he bidding process for the external acquisition of information system covers:

System planning and selection: The activities under this phase cover system identification and selection. At this stage, the

information system manager or whoever that is saddled with the responsibility identifies and assesses all possible systems development projects that an organization or its unit could take. Also, those projects deemed most likely to produce significant benefits to the organization as a whole are selected. Requests for information systems development can come from either the managers and organizational units, information systems managers or formal planning group. The system selection decision outcome could be either accept project, reject project, delay project, refocus project, end-user development, purchase system or modify and resubmit

System analysis: This is a process of collecting and interpreting facts, identifying problems and decomposition of a system into its components. This process is carried out to study a system or its parts in order to identify its objectives. It is a problem solving approach that enhances the system and ensures that all the components of the system work perfectly to accomplish their purpose.

Development of proposal request: This is also known as a proposal development process in which organizations respond to a buyer's request for proposal. A request for proposal (RFP) is a business document that announces a project, describes it, and solicits bids from qualified bidders to complete it. The requests include a statement of work describing the tasks to be performed by the winning bidder and the timeline for finishing the work (The Investopedia Team, 2024).

Proposal evaluation: This is the evaluation of the completeness and efficiency of the proposed technical approach to meet the system and its requirements.

Vendor selection: This is a critical part of the procurement process. It involves investigating the potential vendors, defining the system and gathering requirements, developing selection criteria and creating a Request for Proposal, assessing vendors, and negotiating

to finalize the deal. During the negotiation, it is imperative to ensure that the deal is fair, and the terms are reasonable, and that the vendor can meet the system's requirements.

The first two steps, system planning and selection and system analysis, are also known as Software Development Life Cycle (SDLC). These two steps are followed by the development of proposal request deals with the provision of the summary of the existing application and system. The System features and performance, evaluation criteria, budget, and service requirement is provided. The fourth step 'proposal evaluation' receives an assessment of the proposal from the vendor and tests are carried out to compare different proposals. The fifth step 'vendor selection' is the actions taken to determine the best system that fits the users' requirements and specifications. The selection of the system is made based on the performance of the proposed system.

Factors influencing information acquisition method

The following determines the choice of the method for acquiring information system:

1. *Genuineness of the acquisition method:* There must be assurance the method of acquisition of the system is transparent
2. *Warranty:* It is expected that the proposed system to be acquired possesses a warranty.
3. *Price tag for the information system:* There is the need to consider the price of the new system if the organization is capable financially to go for it.
4. *Type of information system:* Of course, the type of information to be acquired is very important, as the qualities of the available systems might be different.
5. *Government policies:* In acquiring a system, there is the need to consider government policies either for or against the

system or any of its parts, and the condition to follow in the bid to acquire them

Factors Influencing Information System Acquisition

Information system acquisition is influenced by:

- *quest for quality product and quality services,*
- *priority for efficiency,*
- *availability of information systems skill and expert,*
- *demand for transparency and accountability,*
- *global demand for information systems and development, and competition.*

Summary

The development and acquisition of information systems involve different processes, challenges and best practices that organizations need to navigate their challenges effectively. As activities involving information system becomes complex and challenging, there is the need to develop a new system that could handle the complexities and challenges of the organizational information. Information systems play pivotal roles of efficient decision making, operations and strategic planning for the attainment of set goals as planned. Another significant role being performed by the information system is the ability to provide essential data and tools for decision makers. Information system development on the other hand deals with the process whereby collective organizational activity is facilitated by new technology. This information system development life cycle covers preliminary analysis, system analysis, system design, programming, testing, implementation, and maintenance. However, information system acquisition is the process of obtaining an information system for an organization. The methods of acquiring information systems are via purchasing, bespoke development, leasing, outsourcing, development, and request for quotient. The reason behind the choice of a method, warranty, price tag for the information system, and type of information system

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Chapter **13**

INFORMATION SECURITY AND CONTROLS

Ajao Anita Folasade & Oladosu Opeola
The Polytechnic Ibadan, Nigeria.
Emails: ajaofolashade121@gmail.com / oladosuolusayo06@gmail.com

Introduction

The emergence of globalization and technological advancement have brought about the need for Information Security commonly known as "info sec", which is the life blood of organizations throughout the world. Thus, the need to protect information in every organization has become inevitable. There have been records of information theft. For instance, large organization such as Yahoo and Microsoft have been affected by information theft in the past ten years. However, the existence of Information Security has helped them to recover from various theft of information and improved performance of recent.

Historically, in 1940s and 1950s, when electronic computers were developed, there were only limited access to them. However, in 1960s and 1970s, security problems emerged. More so, hackers started hacking information on the system. This is because of emergence of internet in 1960s which availed everyone the opportunity to have access to the information on computer system. By 1980s and 1990s, information security gained attention as a discipline. In the year 2000, security threats escalated to the extent that United State introduced Sarbaner Qxley act (S0X) and United Kingdom introduced Data Protection Act to secure information in their system. Although, antivirus and firewalls were introduced to protect

information on system, another dimension of theft arose that was called worm. Thus, by 2000s, cyber theft became very serious and in 2010 hacking became more common; and various cryptoghic algorithes and encryption technology were adopted to curb them. Since that time, various organizations have adopted Information Security system and policies to control human errors and breaching of the data. Invariably, information security becomes indispensable in every organization.

Furthermore, the concept of Information Security is sometimes mistaken for Cyber Security. So, Cyber Security is the larger structure and a general term in which Information Security is a unit. Also, Information Security is meant to protect data from being stolen while Cyber Security deals with overall security of the computer system and data. This is why Ahassan and Adeji Quaye (2017) define Information Security as the act of defending information from unauthorized access, disruption, modification, perusal, inspection, recording, or destruction. Thus, Information Security involves constantly improving organizational effectiveness and investigation or attack reduction.

Handling of information in organization

Since there is always the existence of product complexity and different products evolving due to technological breakthrough, different organization need to evolve new information security. Also, information emerged from data and knowledge from information through which wisdom can be achieved. In most cases, information is used to describe work instructions in an organization. Thus, this can exist in automation and ergonomics. Automation involves information about skill- rule and knowledge based behavior while ergonomics is based on the quality of work. Thus, information must be well handled in an organization.

Furthermore, information is handled through media routing, clamping, equipment, controlled assembly, hole pattern recognition, hidden assembly, console assembly and reverting (Johasson, Enofe, Moritz, Malmskold, Bergund and Moestam, 2017). Thus, information can exist in an organization in form of general information, corresponding information and unique information. They further added that there is no common strategy of handling information. However, some basic ways of handling information will be discussed.

File information are information that is kept in files. This can be general, personal, restricted, confidential, and top secret. The method use is to keep the hard copy locked. Then, there must be regular authorization from the manager before it can be accessed and at times, there is the use of coding and decoding to open and translate different files. Then, there is the organization method of collecting and dispersing information on legal and organization policies.

Furthermore each organization determines how to handle confidential, internal use and public form of information. Confidential information in an organization is sensitive information e.g personal records, customers, information, shareholder information, operating plans, marketing strategies and so on. Thus, it is expected that 5 to 15% information in an organization should be confidential. Thus, this must be well protected with adequate information security. Again, the internal use information include phonebook, standard procedures, co-operate policies etc. This is always 70 to 90%. There are handled by accounting legal and personnel departments alone. However, public information are made available to people through authorized company channels. They are not sensitive like others.

From the above, information handling takes place when information is obtained and classified into various parts. For instance, information labelled confidential must be protected through document scanning or cloud based platform. Thus access to confidential information is

approved through authorities and stored through a consistent classification of information such as "not in use", "paper based information stored", "computer based information stored" and so on. So, there must be provision of software to protect it from unauthorized access.

Also, the disposal of information should be done according to the organization intention schedule. In addition, every organization has its information security programme administration such as protecting organization policies and procedures, structure of the establishment, direction and scope. Then, there must be corporate information steering committee. This consists of manager, coordinators and trainees. Also, information security co-ordinators are to manage every area of risk management.

Importance of information and information system

Information is the life wire of any organization. Therefore, its importance cannot be underestimated. Some of the importance of information and information system are as follow:

(a) Tactical decision is very vital**.** Information and information system help to take tactical decision. The availability of information exposes the organization to every options, methods, processes and activities. Thus, tactical decisions is made possible for the organization on how efficiency can be improved.

(b) Departments are connected together. Through information system, each department gets connected to one another. The procedural ways of information makes different departments to connect to one another for successful implementation of policies or for execution of a plans.

(c) Competitive advantage is needed**.** Through information being protected, the organization is able to compete effectively and efficiently with other organizations. It is able

to execute new policies and introduce new brands to win the market against other competitors.

(d) Enhanced performance of management is important. This is ensured through information of the employee details and work activities acquired. The management can easily detect operational lapses and other things needed to ensure smooth operation.

(e) Shared goals, operations and relationships are indispensable: Since all the goals and operation of an organization are stored inform of data, this can easily be shared among the employees. This enhances sharing of goals, operations and good relationship, since everyone is informed about everything concerning the organization.

(f) Easy accessibility to the operation of an organization must exit**.** The employees find it easy to understand the operation of the organization through the stored informational system. Thus, the organization will be able to operate smoothly

(g) Chain Management must be ensured. Information and good information management enhance chains management. Since there is availability of information from the top to the lowest cadre in an organization, chain management is enhanced.

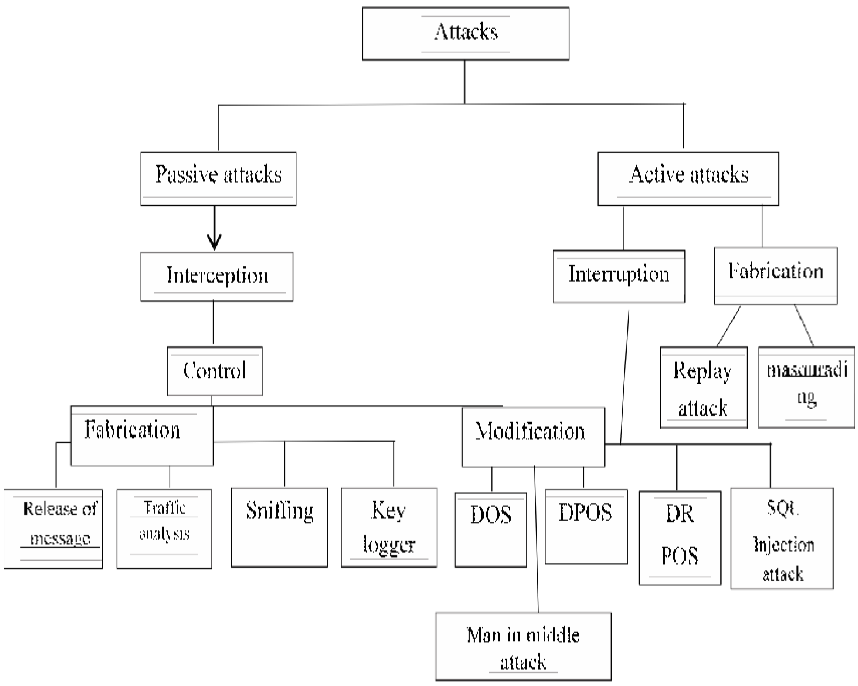
Information System Vulnerability, types of attacks and control mechanism.

Information System Vulnerability refers to the weakness in the organizational information system, since information is susceptible to various attacks. Thus, there are two types of attacks- passive and active attacks. Active attacks occurs when the attacker attempts to modify the content of the message. However, in a passive attack, he observes the messages and copies them.

Furthermore, some of the methods used in passive attack include release of message contents, traffic analysis, sniffing and key loggers.

Active attack can be divided into three viz interruption, fabrication and modification. Furthermore, the principles of security determine the security threats and how to control them. Such principle include accuracy, access control, confidentially, integrity, identification and communication.

Diagram one: Types of Information attacks



Source: Adopted from Khaleed, Shikha, Nitesh and Jayant (2011)

For passive attack, interception is done without the permission of user. It can be divided into two subtypes which are traffic analysis and release of message contents.

***Release of message*:** It occurs when someone sends a message that only a person can read it and an unauthorized person is able to read it. This can be protected by encoding the message using algorithm

***Traffic analysis*:** This is when message passes through a single channel and the information is given to the attackers because of confusion.

Sniffing: This is the transferring data to the sender. Thus, the attackers tries to find out about the data without the permission of the sender.

Key loggers: It runs in the background by recording every keystrokes. If such information is shipped raw to the attackers; then key-logging takes place. Thus, the system can shut down to deny legitimate users access to this.

Fabrication

Attackers use accessing services that they are not supposed to use. It has two attackers. Firstly, replay attack. This is an attack in which transmission is repeated or delayed. The attacker is able to get the authorized data and send it to his personal account. Those can be controlled using strong digital signatures, using stamps and unique information from the previous transaction such as sequence numbers.

Masquerading: This entails the attacker assuming the identity of another to gain access to confidential information.

Modification: This brings about losses of integrity because the attacker is the middle person that falsifies information. For instance, if someone transfers 100 naira to another person, the attacker is able to change it to1000 and divert the money to his own account.

Man of the middle attackers (MITM): This is a situation when attackers alter information between user of the network and the person the information is meant for. This is called theft and fraud of information.

Types of Active attacks

Interruption: Is an active attack in this situation the attacker pretends to be the authorized person. It has four types. They include *Denial of service (DDOS)* – The legitimate users are denial access while the hacker is given the access;

Distributed denial of services (DDOS) – In this attack, compromised system attack a target. The flooding of incoming messages recent for the owner is received by the attackers

Use of Dos with Reflector (DRDos) – It is a reflector that helps attackers to do a secure attack and it is always difficult to trace.

SQL injection attack – This makes security vulnerable and it occurs in data based layers of application. Thus, SQL allows the attackers to interact with the web applications to carry out theft.

Control Mechanism

Since attackers come in form of many vectors such as web traffic, e mail, mobile devices, automated export, they work every time of the day to steal information. Every target of attack is called an IP address or prospect for watering the hole. Thus, attackers can launch phishing emails Therefore, Organization need automated tools to scrub the

traffic created by hackers, protect and point and filter mails. Firewalls can also be run to protect information. This should use a sand box network and cloud to provide information about malware.

In addition, there are also many new malware variants created to ensure information security Thus, organization need to update them constantly. Security gadgets installed must also update protection at firewalls gate, mobile and remote end point (Vincent, 2006). Since information attackers attack vectors and malware, Trojans are used to steal sensitive system data. Thus firewalls can protect information being stolen from malware, Trojans, spyware, and ransom.
Other measures of control include

- Network boxing that sends warning about never seen malware
- Network based malware protection to block attackers

The security solution to human attacks by phishing is through the use of malware protection by ICSA Labs. This is a sophisticated firewalls that protect network from internal and external attackers. Again, another control is through social responses. It is an effective way of control when people are made to be aware of phishing attempts. Technical responses are anti-phishing measure embedded in browsers. Such as.

- Helping to identify legitimate sites
- fake websites

Thus, internet explorer 7 and firefox 2 can easily detect most fake websites.
Khan and Sylvester (2024) suggested the use of Artificial intelligence (AI) and Machine Learning (ML) for detection of attacks. This is because AI and ML have predictive capabilities for the impending attacks, automated response and continuous learning. ML learns from past attacks with predictive accuracy and response strategies.

Information system ethics and computer crime.
Ethics generally are rules guiding performance to safeguard individuals and organizations. Information system, on the other hand, focuses on the relationship between the creation, organizational dissemination and use of information. Therefore, information system ethics refer to way of ensuring proper use of information. Ragerson (2010) rooted the beginning of information system ethics to the mid – 1940s. Since then, information system ethics are still very relevant today. Information system ethics are accuracy, ownership privacy, accessibility and code of conduct. Accuracy means information must be precisely stated. Ownership shows that the information is owned by an individual or an organization and not a third party. In addition, privacy entails that information is confidential to an individual or in an organization. Also, accessibility means that information is available to an individual through authorized means. Lastly, code of conduct shows there is always a procedure involve in authorization of information. However, as good as these ethics are computer crimes are still prevalent negating these information system ethics, computer crime is any crime committed with the help of a computer. Of recent, it has been a major concern for law enforcement agents everywhere in the world. Some of these computer crime include:

Logic bombs – This is a programme introduced to cause unauthorized functions.

Trojan horse – This is used to steal hidden content in a computer

Pharming – This occurs when hackers divert website traffic to another location owned by them. Thus, the victim host file is changed as a result of vulnerability in software.

Spoofing– This is a technique used to gain access to computer messages because IP address is found by hacker.

Spyware – Is a software used to remove confidential information by hackers. Anti-spyware gadget must be installed to fish out spywares. Opera and maxilla fire-fox suffers vulnerability. Inclusion of explorer makes it uneconomical for hackers to infiltrate. However, internal explorer is also vulnerable with its 'active x'.

Information brokers – They are hackers that sell information to people requesting for such electronically. The solution is that information brokers industry must be regulated. Trojan horse installs itself on the hard drive and runs. When windows are started for attackers to infiltrate.

Identity theft – This occurs when hackers assume someone identity to practice malfunction copy right.

Infringement – This entails the unauthorized use of copy right materials

Click fraud – This when illegal click is done on the computer system to make more money.

Hacking- It is used to bypass security controls and to gain access to a system without authorization.

Computer virus – This is introduced to steal sensitive data or to control the computer illegally.

Summary

This chapter has examined information security and control mechanism through exploring the following topics. Handling of information in an organization, importance of information and information systems, information vulnerability, attacks and control mechanism and finally, information ethics and computer crime. Thus, from everything discussed in this chapter, it is therefore important for every organization to take a proactive step toward ensuring security

of information, which will go a long way in reducing or destroying various threats to information as well as computer crime. It is invariably inevitable that information is the heart-beat of any organization for efficiency and effectiveness to be realized, and attainment of organizational goals.

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