Cape Peninsula
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# An Assistive Technology Framework for Visual Impairment Students in South African Higher Education Institutions

**by**

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**Signed:** **Date: August 2025**

**ABSTRACT**

South African higher education institutions enrol students based on requirements stipulated by each institution. This includes students without or with any form of disabilities, such as visual impairment. All students are entitled to have access to quality education. Visually impaired students are experiencing challenges with their studies despite the government policies that promote inclusive education to all. Higher education institutions provide visually impaired students with assistive technologies to support their learning needs and to eliminate the inequality in the classroom, especially with practical classes. However, the assistive technology is not serving the needs of visually impaired students. These challenges manifest from a lack of the most appropriate assistive technology that can support visually impaired students with their studies especially with practical classes. The aim of the study is to develop an assistive technology framework, for visually impaired students, for learning purposes in practical sessions or classes in higher education institutions in South Africa.

To achieve this aim, the study selected case study approach as a design. Two cases were selected from higher education institutions using a set of criteria. One institution was Technical Vocational Education and Training (TVET) and the second case was University of Technology. Participants were also selected according to set of criteria. Data was collected using semi-structured interview technique to allow participants to have the flexibility to elaborate on their experiences. The interviews were concluded after interviewing the last participant. The reason being limited participants based on the criteria. Ethical considerations were adhered, according to the University (CPUT) ethics rules, that all participants should participate voluntarily without receiving any incentives.

Data was analysed using diffusion of innovation (DOI) and Contingency Theory (CT) as a lens. Thus, analysis was guided by communication channel (DOI), namely: knowledge, persuasion, decision, implementation, and confirmation for both cases. Ten factors were identified after mapping the findings to eliminate duplications. These factors manifested related attributes, that were used to develop the selection of the most appropriate assistive technology for visually impaired students especially with practical classes. The factors were interpreted through four components of CT: strategy, structure, environment, and performance. Thus, the interpretation followed subjective approach. Based on the factors and attributes, an assistive technology framework for visually impaired students was developed, for learning purposes in practical classes in higher education institutions in South Africa.

This study contributes from three main perspectives: theoretically, practically, and methodologically. Theoretically, the identified factors influence the selection and the use of the most appropriate assistive technology. Practically, the factors encourage collectiveness among stakeholders to support visually impaired students during practical classes. Methodologically, the combination of contingency theory and diffusion of innovation is a significant contribution of the study. The main contribution of this study is the developed framework. The framework can be used by stakeholders (visually impaired students, IT technicians, educators, and management) in their collaborative efforts towards supporting students with visual impairment using the most appropriate assistive technology. Recommendation of further study were based on the findings, which include training and awareness, governance, and system repository.

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## DEDICATION

I dedicate this study to my late grandparents, Dikeledi A. Gama and Piet Gama. I am principled because of the values you have instilled to my upbringing. To my late lovely mother Maureen R. Gama, your love has always lifted me up and the way you embraced peace and unity. I miss you and I will always cherish the good times we spend together as a family.

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# CHAPTER ONE
# INTRODUCTION

## 1.1 Introduction

Higher education institutions in South Africa undertake to admit students with disabilities, including those with visual impairment (Department of Higher Education and Training, 1997). Students who enrol at any of the higher education institutions must meet the minimum requirements for admission to their selected qualification. Progression of enrollment has attracted students with visual impairment as well. The current focus of higher education institutions is teaching and learning through technology. Technology changes rapidly from time to time to enhance teaching and learning methods. In this development of rapid change, higher institutions ensure that there is no discrimination against learners with disabilities to promote their successful inclusion in the system.

South Africa has developed policies, for example, the White Paper on the Rights of Persons with Disabilities (Department of Social Development, 2016), which promote the inclusion of people with disability in higher education and provide necessary support to access a broad spectrum. The emphasis of the policies does not eliminate the challenges faced by people with disability in higher education, especially the totally blind students. According to Niraula (2024), visually impaired students still have challenges with inaccessible academic programs and a lack of learning resources to support their learning.

In fairness, people with disability in higher education are not adequately prepared to face this new environment (Lourens & Swartz, 2021). A disability may differ from one person to another, depending on the condition of an individual. According to McKinney and Swartz (2022), South African higher institutions still lack the knowledge of how to handle people with disability, including the visually impaired, within the environment. People with disability need special attention.

Visual impairment has been described as an umbrella term for loss of vision that ranges from partially sighted to total blindness (Mboshi, 2018). The focus of the study was on people who are totally blind. People with visual impairment need even more attention compared to sighted students in their learning environment. Despite the inclusion of people with visual impairment in higher institutions, Croft (2020) indicated that these people still experience difficulties in their educational space. In some instances, their learning environment does not provide relevant equipment to support them. Lourens and Swartz (2020) emphasised that such students need social coherence to ease their path.

It is important for higher institutions to have assistive technology to assist students in pursuing their careers of choice (Dalton, 2019). This implies that visual impairment constrains information exchange by visually impaired students. Such people face various barriers deriving from their internal and external environments. Different types of assistive technology are classified according to individual needs of the impaired. (Hu et al., 2019). Students' performance improves according to the use of relevant technology in their different levels of education. Educators are expected to provide support to enable students to achieve their career goals (Van Dijk, 2020).

## 1.2 Research problem

In South African higher education institutions, many visually impaired students and educators are increasingly challenged when it comes to teaching and learning (Croft, 2020). The challenges are worse for practical classes when students are engaged in or assigned practical tasks in their studies. The challenges are either a lack of access to assistive technology for teaching and learning, or limited information about the technology, or both. Also, many learners do not know how to apply assistive technology to obtain information (Beingolea et al., 2021). This is primarily because they do not have access to assistive technology, a tool that provides visually impaired students with the ability to seek and use information, which helps them to participate in their practical classes independently.

The main problem is that when and where assistive technology is accessible, applying it remains challenging for the users (educators and visually impaired students). As a result, few visually impaired students enrol for courses such as computer science and engineering that have practical sessions as their core aspect because of the problems they encounter during practical sessions or classes. As the challenges persist, some students drop out of the institutions, and others perform poorly in their academic pursuits. This makes the need to find solutions to the problem critical.

## 1.3 Aim of the study

The study aimed to develop an assistive technology framework to aid visually impaired students in higher education institutions in South Africa to learn in practical sessions or classes. Based on the aim, the objectives are articulated as follows:

i. To identify factors that can guide the selection of the most appropriate assistive technology for visually impaired students in practical sessions or classes.
ii. To determine the factors that could influence the use of assistive technology by visually impaired students and those supporting them.
iii. Based on objectives one and two, a framework will be developed to guide the selection of the most appropriate assistive technology.

iv. To provide guidelines on how to apply the assistive technology framework by visually impaired students and those who support them.

### 1.4 Research questions

In achieving the above objectives, the following investigative questions are formulated:

I. What are the factors that can guide the selection of the most appropriate assistive technology for visually impaired students in practical sessions or classes?

II. What are the factors that could influence the use of assistive technology by visually impaired students and those supporting them?

III. How can an assistive technology framework be developed to guide the selection of the most appropriate assistive technology for visually impaired students in practical sessions or classes?

IV. How can the assistive technology framework be applied by visually impaired students and those who support them?

### 1.5 Literature review

The section presents a review of the literature related to the study. It focuses on the core aspects of the study, visual impairment and assistive technology, including the theories that underpin the study.

#### 1.5.1 Visual Impairment in Teaching and Learning

Visual impairment refers to the constraints of people who are blind or have a significant loss of vision, even those with corrective lenses (Nanjwan et.al., 2019). Vision has an impact on day-to-day performance, social life, and education. Visual impairment has been described differently as a loss of vision, which reduces the ability to see, from different degrees to total blindness. The reduction of sight may be irreparable, while others may be corrected by using glasses (Matsei & Stofile, 2021; Naipal & Rampersad, 2018). Visual impairment and blindness can happen during birth, suddenly, or over a period, because of different diseases.

The focus of higher education is to improve students' skills and knowledge base through teaching and research (Chankseliani et al., 2021). Based on skills, education creates employment, social mobility, economic growth, and economic development. Ndebele and Gadisi (2022) stated that the brain and vision are connected, and in most cases, teaching and learning are through vision. Therefore, students with visual impairment must adjust and seek alternative means. Vision does not restrict learning. However, content and practical subjects need more effort and support (Manis et al., 2021). Sometimes, support services have limited coordination in the broader teaching and learning initiated by the institutions.

### 1.5.2 Assistive technology

Assistive technology serves a vital role in fulfilling the information needs of visually impaired people. Assistive technology is described as a tool designed to normalise or improve the functionality of disabled persons (Viner et al., 2020). Assistive technology is introduced to enable visually impaired students to participate not only in their education but also in their everyday life routine. Naipal and Rampersad (2018) confirmed that visual impairment restricts everyday life, including the struggle of daily reading and writing. Visually impaired students need assistive technology to undertake their educational activities within the learning space and enhance their daily life (Senjam, 2019; Hu et al., 2019). Viner et al. (2020) indicated that visual impairment requires low and high-tech assistive technology to achieve and live a normal life.

However, such students need high-tech devices, especially in practical subjects such as computing. Amin et al. (2021) stated that the obstacles faced by visually impaired students include facilities, the environment itself, and human factors, from peers to educators. They also have difficulty seeking and accessing information (Alotaibi et al., 2020). According to Du Preez (2019), information activities such as information seeking, searching, sharing, and use are prompted by an information need. Assistive technology eases information activities. Information needs differ from one person to another. Most information is easily accessed and shared through vision. Schuck et al. (2019) mentioned that technology is needed by visually impaired students; however, opportunities are limited to learn how to use technology effectively. Visually impaired students seldom engage in using electronic resource centres compared to their peers.

Despite the criticality of assistive technology, it is either not accessible or users are challenged by how to apply it in South African higher institutions. According to Viner et al. (2020), each student requires a needs assessment to allocate the most appropriate assistive technology to improve effective learning. Darabont et al. (2020) suggest that assistive technology can be complex; however, the technology is safe and allows the visually impaired to be self-oriented. The complexity is a persistent challenge that needs a solution. Additionally, few educators are trained to teach with technologies that favour visually impaired students. Also, the factors that influence the training are not empirically known. Selepe and Molelemane (2022) emphasised that educators are not skilled enough to facilitate a class with visually impaired students. Lintangsari and Emaliana (2020) stated that educators need to accommodate and consider visualising the teaching concept for such students to have a better understanding.

Practical subjects or classes focus more on hands-on skills that students acquire while learning. Thus, Stefik et al. (2019) stated that it is still challenging to include visually impaired

students in practical subjects or classes. However, there is a possibility of accessibility through unplugged activities with relevant assistive technologies.

### 1.5.3 Highlights from related literature on visually impaired students and assistive technology

- Visually impaired students have limited choice of subjects from the respective special schools that prepare them for tertiary education (Lourens & Swartz, 2021; Tekane & Potgieter, 2021). Teaching practical subject requires strategic teaching methods. Most higher institutions find it difficult to identify the perfect strategy for the visually impaired. It is difficult to facilitate teaching, especially when impairment happens in the middle of the course (Palan, 2021). Tom et al. (2021) emphasised that there are few enrolments of visually impaired students for practical subjects, especially engineering.
- Assistive technology is a device that assists visually impaired students to normalise their daily activities and make learning possible. However, one in ten have access to the relevant assistive devices (Manase, 2023). According to Ndlovu (2021), higher education institutions have successfully included visually impaired students in the system with limited provision or without providing relevant assistive technology.
- Visually impaired students lack support in the education environment, in developing and developed countries (Montenegro-Rueda et al., 2022). Educators lack the knowledge and skills on how to support visually impaired students. Challenges are more in science, technology, engineering and mathematics (STEM) subjects because of their technicality and practical aspects (Kisanga & Kisanga, 2022; Adelakun, 2020; Tom et al., 2020).
- Access to infrastructure is a serious challenge for visually impaired students in higher education institutions. Buildings are situated at a high level and inaccessible (Ndlovu, 2021). Mobility is also a challenge as disability units have limited resources and the architecture around the university does not cater for the student (First & Koyuncu, 2021).
- Institutions have limited assistive devices for all students, and in particular cases, the technology is old because of inadequate funding (Kisanga & Kisanga, 2022). Where assistive devices are available, there is a lack of training on how to use them.

### 1.5.4 Conceptual framework

Based on the aim, as stated in Section 1.3 above, the study focused on how technology is diffused. As a result, two socio-technical theories, diffusion of innovation (DOI) and contingency theory (CT), were selected to underpin the study. The theories were considered the most appropriate because of their focus. Primarily, this is because the theories are most complementary in the context of the objectives of the study. The theory, DOI, was used for analysis, while CT was used for interpreting the findings.

The DOI theory focuses on the decision process and structured communication in the spread of an innovation over a period (Rogers, 2003). Keitany et al. (2020) explain how the theory guides the spread of innovation within an environment. Based on an adoption, the diffusion gradually processes how individuals perceive the concept or innovation. Rogers (2003) describes diffusion as a process in the sense that innovation is communicated over time amongst participants. Thus, an innovative message can be transferred slowly or speedily among interested persons or groups with similar characteristics to achieve a common goal.

Increasingly, innovations are explored and applied to fortify and improve teaching and learning activities in higher institutions. Iyamu (2021) indicated that innovation is not a single act, but a process initiated by an idea. The idea can manifest from old to new technology. Rogers (2003) proposed four main elements that influence the spread of new ideas in DOI; innovation, communication channels, time, and a social system. The elements focus on how new technologies are adopted over time among participants. As shown in Figure 1.1, the communication channel is embedded with process-oriented components that facilitate diffusion of innovation within an environment (Rogers, 2003). These components ease the transition process of visually impaired students in practical sessions or classes. The components which guide the spread of an innovation are five: knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003).

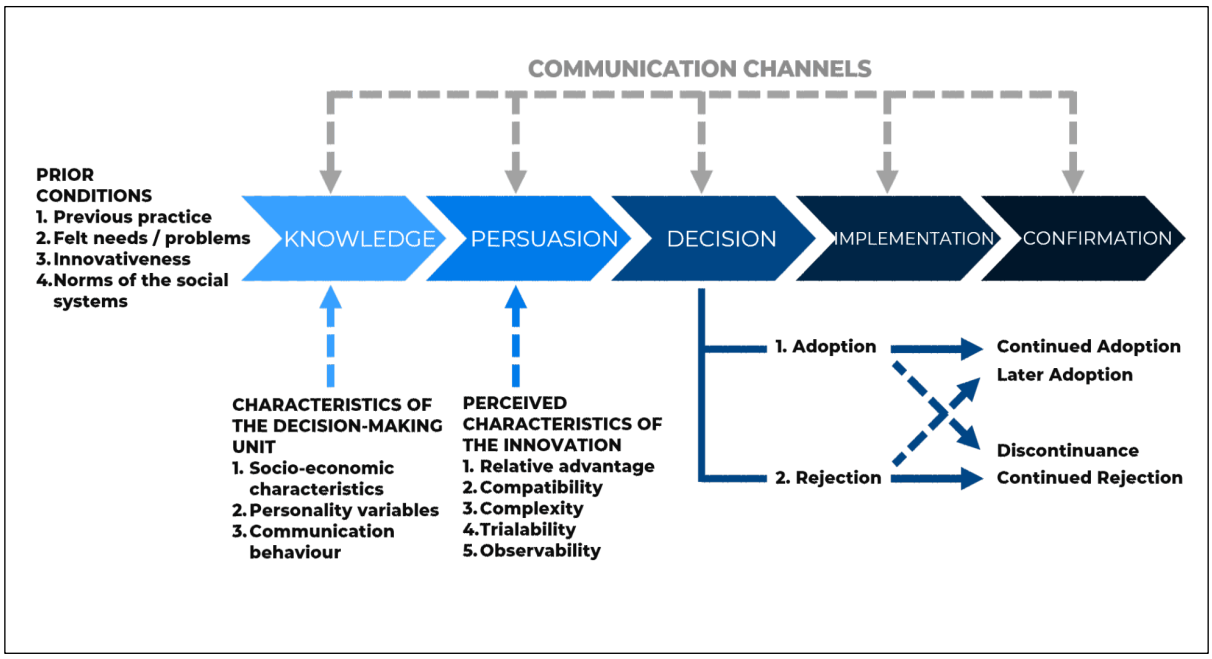


**Figure 1.1: Communication channel (Roger, 2003)**

DOI was applied to understand how visually impaired students adopt and use assistive technology for practical sessions or class purposes. Also, the theory helps to examine how students adapt to change relating to assistive technology. However, DOI does not focus on

providing or assisting to find alternatives in the use of assistive technology by visually impaired students.

Contingency theory (CT) focuses on enabling factors to provide strategic options and effect change (Miller, 1988). The theory demonstrates the relationship of components in organisational performance, which drills down to individual circumstances. Tsolka (2020) argues that CT is applied to guide the transition process, as events and activities manifest. This results from CT's dependence on both internal and external factors that fit an organisational strategy (Harney, 2016). The focus is more on attaining the perfect fit rather than misfit in practical classes. Through its components, as shown in Figure 1.2, CT facilitates the transition from the current approach (traditional method) to the use of assistive technology by visually impaired students during practical sessions or classes.

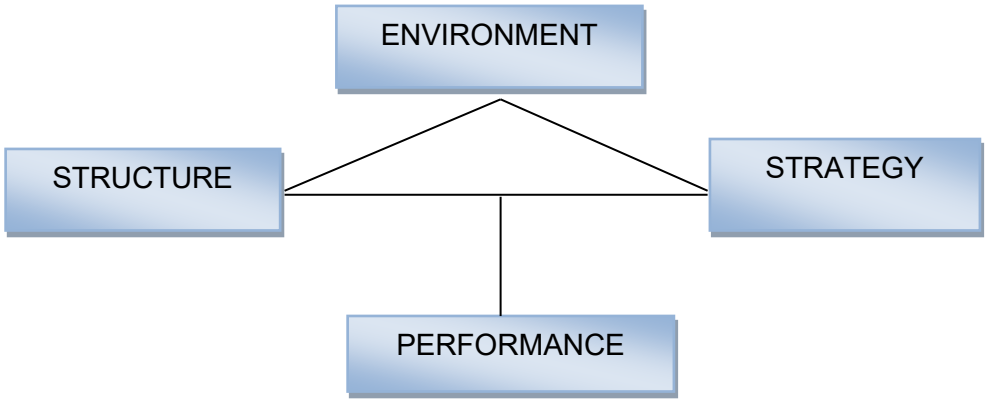


**Figure 1.2: Contingency Model (Miller, 1988)**

CT receives direction depending on the contingencies desired (or required) by the situation. The components of CT interact with each other to align towards the positive outcome of an event within an environment. Thus, the use of CT can assist in adapting to the new way of teaching visually impaired students in practical classes in higher institutions.

## 1.6 Research methodology

The section outlines the methodology that would be employed in the study, as guided by the objectives and questions. Table 1.1 presents the methods, approaches, and techniques of the methodology. This is followed by explanations of the methodology.

**Table 1.1: Summary of the research process**

| | |
|---|---|
| Research philosophical assumption | Ontology/Epistemology |
| Philosophical stance | Interpretivism |
| Research approach | Inductive |
| Research methods | Qualitative |
| Research strategy | Case study |
| Data collection technique | Semi-structured interviews |
| Data analysis and interpretation | DOI and CT |

### 1.6.1 Research philosophical assumption

Research philosophy is about belief and assumption expected to provide a foundation for the phenomena being studied (Coates, 2021). The commonly known philosophical assumptions are ontology, epistemology, and axiology (Rowe, 2018; Schultze et al., 2020). Of the existing philosophical assumptions, ontology and epistemology inform studies of the relationships between information technology, people, and organisation (Hassan et al., 2018; Orlikowski & Baroudi, 1991). Thus, ontology and epistemology are interwoven and cannot be separated in IS research. This is primarily because many realities exist between IT solutions and people.

#### 1.6.1.1 Ontology

Ontology is related to the what question, to understand the nature of the many realities that exist within context. Yulianto (2021) describes ontology as the nature of what exists or happens in the real world. While Moroi (2020) states that ontology focuses on the nature and structure of existence, where individuals can make sense out of it, ontology emphasises that reality exists.

Ontologically, in this study, relativist ontology emphasised that reality exists, and it is subjective according to individual perception. Thus, visually impaired students exist in higher education institutions, and they have challenges with practical classes (Lourens & Swartz, 2021; Amin et al., 2021; Sözbilir, 2016). Another reality is that the challenges that visually impaired students encounter are different, and the researcher needs to make sense of them. The other reality is that different assistive technologies can be used to assist visually impaired students in addressing their challenges in various circumstances. The challenge of how the technologies can be used is not empirically known in specific scenarios or areas, which informs the epistemological assumption in this study.

#### 1.6.1.2 Epistemology

Epistemology is described as the nature of knowledge that is believed to be true knowledge (Wynn Jr, & Williams, 2012; Yulianto, 2021). Epistemology is related to the How question; to acquire knowledge related to the phenomenon being studied (Leedy & Ormrod, 2021).

Epistemology includes the scope of knowledge that interests the researcher for further investigation and how that knowledge can be acquired (Muchanga, 2020). In essence, epistemology is grounded in how knowledge is created and relates to the beliefs and assumptions about phenomena.

Epistemologically, this study seeks to gather knowledge about the challenges of visually impaired students during practical sessions or classes and how the challenges can be addressed. This includes the development and adoption of a framework to guide visually impaired students on how to employ assistive technology in their practical sessions or classes.

#### 1.6.1.3 Axiology

As a philosophy, axiology is from ontology and epistemology. It focuses on the nature of value (Hassan et al., 2018). According to Saunders et al. (2019) and Maarouf (2019), axiology is based on values and ethics, which is engraved in the Why question. The key element in axiology is the values and beliefs that motivate the research; the value of judgement towards the quality of the phenomenon in question. Based on the focus of the philosophy as described above, it does not relate to this study as the study does not focus on values and ethics.

### 1.6.2 Philosophical stance

Each assumption guided the researcher to take a stance. A philosophical stance is a perspective thought or seen to be pragmatic (Boucher, 2014) with organisational or methodological implications (Schultze et al., 2020). Positivism, interpretivism and pragmatism are the common stances. The philosophies transcend assumptions into practice in IS (Smith, 2006) through positivist and interpretive stances (Wynn Jr. & Williams, 2012). The stances guide the researcher's path to the research approach. The study focused on interpretivism as a stance. The following describes the stance.

#### 1.6.2.1 Positivism

In the positivist world, knowledge is quantifiable through measurable results and observations in a natural setting (Leedy & Ormrod, 2021). Positivism believes that scientific truth is the only way with true meaning. This belief emphasises that knowledge must be true or have a positive meaning and be observable (Junjie & Yingxin, 2022). Positivism supports the notion that reality exists and must be viewed objectively. Thus, positivism is identified from a set of structures and rules, and the rules must be systematic (Leedy & Ormrod, 2021).

The outcome acquired from the positivist position can be generalised because the knowledge is accurate from a statistical analysis perspective (Saunders et al., 2019). Positivism is a stance associated with the quantitative method. This study is neither quantifiable nor does it require measurement of any sort. Thus, this position does not align with the ontological and

epistemological assumptions of this study, which is to subjectively examine how assistive technology can be used to provide support to visually impaired students in higher institutions.

#### 1.6.2.2 Interpretivism

Interpretivism is a relationship between the researcher and the subject researched focusing on an understanding of meanings associated with experience, thoughts, views, and feelings of actors' reality (Junjie & Yingxin, 2022). Interpretivism focuses on the social construction of human factors to overrule the method of natural research to come up with different meanings (Saunders et al., 2019). Interpretivism generates knowledge in understanding human experience to come up with a meaning. Leedy and Ormrod (2021) stated that interpretivism is based on the realistic view where the approach is more subjective than objective. Interpretivism is a stance that is associated with the qualitative method (Coates, 2021); hence, it was appropriate for this study. From a subjective perspective, this study aims to understand the challenges encountered by visually impaired students, examine assistive technology, and propose solutions through a framework.

#### 1.6.2.3 Pragmatism

Pragmatism involves mixed methods, qualitative and quantitative. According to Saunders et al. (2019), pragmatism is compatible with uncovering the truth by understanding social reality and finding value and meaning in the scientific element. This study is not about truth or false. Therefore, it was not suitable as a position to determine the direction of this study.

### 1.6.3 Research approach

In Information Systems research, three approaches, inductive, deductive, and abductive are commonly employed. The approaches are discussed in the context of the current study.

#### 1.6.3.1 Inductive approach

The inductive approach, known as bottom-up, directs its focus from specific to general. Inductive research is carried out by gathering data and identifying patterns from observations to generate meaning from the identified patterns (Al-Ababneh, 2020). Gupta et al. (2022) suggested that the inductive approach is linked with the qualitative method, which is particularly useful for detailed explanations of actors' experiences. According to Leedy and Ormrod (2021), the inductive approach is subjective in its social construct; that is, it is based on actors' experiences, views, and opinions.

This study used the inductive approach to develop a theory in the form of a framework that can guide visually impaired students on how to conduct practical sessions or classes with assistive technology.

#### 1.6.3.2 Deductive approach

In contrast to inductive, deductive reasoning is associated with existing theory through testing and it is used to develop new hypotheses (Saunders et al., 2019). Deductive reasoning is more related to scientific investigation towards logically true or false conclusions. This means that it relates to positivism. For this reason, the deductive approach was not suitable for this specific study.

#### 1.6.3.3 Abductive approach

The abductive method combines both inductive and deductive approaches. Abductive reasoning is based on limited information, and the conclusion might not be guaranteed. Data available may predict true or false outcomes because of the incomplete information available. This approach was not relevant to the current study.

### 1.6.4 Research methods

The two common research methods are qualitative and quantitative (Leedy & Ormrod, 2021). However, the researcher can combine the two methods. This is referred to as the mixed method (Babbie, 2021; Bless et al., 2013).

#### 1.6.4.1 Qualitative research methods

Qualitative research requires a close relationship with participants who describe their lived experiences, including their views and opinions in a normal or natural setting (Leedy & Ormrod, 2021). The qualitative method aims to understand human behaviour as well as in-depth individual experiences (Creswell & Creswell, 2022; Babbie, 2021). For this study, the qualitative method was adopted. This is due to the nature of the study, which requires a deeper understanding of how to employ assistive technology to enable and support practical class participation by visually impaired students. Thus, the method was used to facilitate a deeper understanding of the experiences of visually impaired students during practical classes, including the educators' experiences with the physically challenged students.

#### 1.6.4.2 Quantitative research methods

The quantitative method collects data using numbers and statistics to answer research objectives scientifically (Rana et al., 2021). The qualitative method is more for descriptive research to find the meaning of the case under investigation. Leedy and Ormrod (2021) describe quantitative research as a technique that converts data into a numerical, measurable form to analyse different variables.

#### 1.6.4.3 Mixed research method

The mixed method has been described as a collection of both qualitative and quantitative data in a single study concurrently (Creswell & Creswell, 2022; Park et al., 2020). The mixed method is selected in a situation where qualitative and quantitative methods can be used to achieve sufficient results. The method also gives the researcher the advantage of obtaining in-depth and rich data that is impossible to get with only one method (Park et al., 2020).

### 1.6.5 Research strategy

There are options from the existing strategies that can be applied to research. This includes action research, ethnography, grounded theory, and case study (Mtisi, 2022; Babbie, 2021; Leedy & Ormrod, 2021). Action research is aimed at solving problems as they happen, such as practical problems (Babbie, 2021). The ethnographic approach involves people and allows the researcher to use a cultural lens to find meaning (Saunders et al., 2019). The grounded theory generates new theories, especially when theories about a phenomenon are inadequate (Leedy & Ormrod, 2021), while the case study approach focuses on examining an object or subject in a natural setting (Yin, 2018).

The case study strategy was applied as the research design. According to Yin (2018), the case study approach enables the researcher to explore and investigate the phenomenon within context in a real-life setting. Leedy and Ormrod (2021) describe the case study approach as a systematic and in-depth investigation of a particular situation or circumstance. The case study approach allows and enables comprehensive responses to questions such as “who”, “how” or “why”, which help in describing an entity, to gain a better understanding of the associated social life or reality (Saunders et al., 2019).

Also, the case study approach creates an opportunity for the experiences associated with the phenomenon being studied to unfold in a natural setting (Yin, 2018). The approach is associated with interpretivism, to understand the meaning of the phenomenon. This study employed the case study approach because of its relevance to exploring, examining, and understanding how meanings are associated with events and how information manifests during practical sessions or classes, as visually impaired students experience challenges. This includes how the visually impaired students can or do interact with assistive technology to carry out practical sessions or classes.

Two South African institutions of higher learning were used as cases in the study. The criteria used to select the institutions included a university of technology and a technical vocational education and training institution. This is because the infrastructure in the institutions differ, particularly in caring for physically challenged students. Also, the institutions must grant access before commencement. This implies that ethics were adhered to. In adhering to the research ethics, the universities were represented with pseudo names, Mzanzi University of Technology (MUT) and Orange City Technical Vocational Education and Training (OCTVET), both in South Africa.

### 1.6.6 Data collection

Data collection is an important aspect of research. Different techniques used to collect data include interviews, questionnaires, and observation (Babbie, 2021). Leedy and Ormrod (2021) emphasise that data collection includes any form of documents that can assist in answering research questions. The appropriate data technique was selected following the objectives of the problem under investigation. This study adopted the semi-structured interview and document analysis techniques. There are other types of interviews, structured and unstructured (Bless et al., 2013), which are not appropriate for this study. According to Leedy and Ormrod (2021), the semi-structured interview allows flexibility and the researcher can probe to initiate new questions. Semi-structured interviews permit people to express their views and broadly define issues (Babbie, 2021).

#### 1.6.6.1 Semi-structured interview

Data was collected from educators, visually impaired students, disability coordinators/ managers and the enablers of the technology (IT technologist). Criteria were used to select the participants. Ethics was considered in the set of criteria. The interviews were conducted one-on-one, and in person (physical presence). The interviews were concluded after interviewing the last participant because of the limited number received according to the criteria.

Permission was obtained to tape record the interviews. The recorded interviews were transcribed. The transcripts were labelled with the pseudonyms assigned to the participants. For example, the participants in Mzanzi University of Technology were coded as MUTni01, MUTni01 . . . MUTnin+1, and Orange City Technical Vocational Education and Training (TVET) participants as OCTVETni01, OCTVETni01 . . . . OCTVETni n+1.

### 1.6.7 Data analysis

Data collected was analysed using the diffusion of innovation (DOI) theory. A review of the literature was conducted on the theory, as presented in section 1.5.4. DOI was applied for two reasons: (1) it is crucial to know the type of assistive technology adopted to examine the contingency associated with it; and (2) it is significantly valuable to understand how and why the assistive technology was diffused.

The DOI was used to (1) understand the decision-making process in selecting and adopting the assistive technology, to enable and support visually impaired students; and (2) examine how visually impaired students adopt and use assistive technology in their practical classes.

## 1.7 Justification of the study

This study was justified by its significance to society and the academic domains. Visually impaired students experience isolation in social environment and higher education institutions. Higher education institutions offer equal access opportunities to qualifying students, and the learning environment mostly depend on vision (Selepe and Molelemane, 2022). Thus, visually impaired students continue to phase challenges because of their uniqueness in terms of accessing learning materials. Despite the awareness of available assistive technology and inclusivity to quality education, visually impaired students continue to lack support or access to relevant assistive technology. Walton and Engelbrecht (2024) emphasised that there are inadequate policies that support the visually impaired students in the learning environment. From the societal perspective, the study was significant to both visually impaired students and their parents, including the sponsors of their academic pursuits. Primarily, the study provides a guide on how to access and use assistive technology for visually impaired students. This reduces the burden on the parents and sponsors of the students.

To the academics, the study's outcome was intended to advance the teaching and learning method. It provided a framework that guides educators on how to govern and manage information related to the adoption and use of assistive technology for visually impaired students when it comes to practical sessions or classes.

## 1.8 Contribution of the study

This study contributes from three main perspectives, theoretical, practical, and methodological, as described below.

### 1.8.1 Theoretical contribution

The main theoretical contribution of the study comes from the framework that was developed. Other theoretical contributions are the factors that influence the selection and use of the most appropriate assistive technology by visually impaired students, which is a significant input and guides in developing policy. In addition, the development of a framework is to guide stakeholders on how to select the assistive technology for visually impaired students. It served to review and add value to the current literature on assistive technology and the visually impaired. This also contributed to scholarly literature that focused on visually impaired students interacting with the appropriate assistive technology.

### 1.8.2 Practical contribution

Practically, the framework provides a guide on how educators and visually impaired students can select, use, and manage assistive technology for practical sessions or class purposes. This includes how technology is used to source and apply information relating to their practical tasks. Practically, the factors of influence revealed, bring a sense of collectiveness among the

stakeholders on how to support visually impaired students in applying assistive technology for learning purposes.

### 1.8.3 Methodological contribution

The methodological contribution of this study includes the use of sociotechnical aspects to examine how assistive technology can be diffused to advance visually impaired students' learning during practical sessions or classes. Also, the complementary use of contingency theory and diffusion of innovation is a significant contribution from an academic perspective. In this area of the phenomenon being studied, no study seems to have combined the two theories. The study contributed through interactive teaching of practical subjects by making students independent and reducing inequality between the sighted and the visually impaired.

## 1.9 Ethical consideration

The nature of the research and the use of the case study approach required confidentiality. Ethics were essential for both researchers and participants. This means that, in this research, the researcher adhered to the rules of the University (CPUT), and participation by individuals and groups was voluntary. Thus, the researcher ensured anonymity for all participants by not always recording or disclosing their identities. Confidentiality and anonymity were guaranteed by ensuring ethical principles that protect the identity of the respondents (Cresswell & Cresswell, 2022). The researcher informed participants that no information would be available to the third party. To protect virtually impaired students and the university, there was an approval from the university's ethics committee.

## 1.10 Conclusion

The chapter presented a problem of critical relevance to both societal and academic challenges. It demonstrates that the problem can be solved through research. Also, the most appropriate approaches, methods, and techniques were used to realise the aim of the study. The contributions are highlighted. The ethical considerations that guided the research are outlined. The research was completed within the period prescribed by the University.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.1 Introduction

This chapter presents the literature review, which is guided by the objectives of the study as stated in Chapter One. Thus, the review of the literature focuses on the core aspects of the study. This includes visual impairment, and technology adoption and enablement. Also, covered in the review are the theories that underpin the study.

The chapter is divided into seven main sections. The first section is the introduction. The second section discusses visual impairment. In the third section, visual impairment is discussed within the context of higher education institutions of South Africa. The fourth and fifth sections cover assistive technology and adoption of technology, respectively. In the following section, socio-technical theories are presented, which are diffusion of innovation and the contingency theory that underpin the study. Finally, the chapter is summarised.

## 2.2 Visual impairment

Visual impairment has an impact on daily life of people living with the condition. Visual impairment is defined as a permanent condition that cannot be corrected, where individuals experience inability to see or no vision, and these people are restricted from performing visual activities (Naipal & Rampersad, 2018). WHO (2022) describes visual impairment as a limitation of eye activities in vision and the visual system. Tom et al. (2021) indicated that visual impairment refers to both partial sight to total blindness. Visual impairment limits the ability of affected people to perform their daily activities independently, in education, employment, and the social environment.

Eyes have different parts that work together to enable people to see. Vision is considered as how well eyes can see, which happens through the brain (Esra & Mayet, 2020). Vision cannot happen without good eyesight; in contrast, poor eyesight results in vision loss (Klauke et al., 2023). Vision has been measured by visual acuity to determine the clarity of an eye. Several studies indicated that a visual acuity of <3/60 indicates blindness or severe visual impairment (WHO, 2022; Esra & Mayet, 2020). Vision screening is important to determine the impairment on time (Nguyen et al., 2022). Impairment is associated with disability that refers to the weakness or a form of eyesight loss (Esra & Mayet, 2020). Impairment of the eye affects vision.

## 2.3 Challenges of visual impairment

Students with visual impairment must have equal access to higher education institutions in South Africa (South African Department of Higher Education, 2018). Despite the successful integration of visually impaired students in higher education institutions, students continue to

face different challenges in their learning environment (Baepler, 2023; Selepe & Molelemane, 2022). The most common challenges faced by visually impaired students in higher education institutions are general attitude and social environment, environmental facilities, and teaching and learning (Selepe & Molelemane, 2022; Zegeye, 2022; Lintangsari & Emaliana, 2020). Negash and Gasa (2022) highlighted improper balance between inclusion and resources that facilitate the teaching of visually impaired students in higher education institutions.

Higher education institutions lack sufficient funding, which affects both students and the institutions (Amin et al., 2021). Visually impaired students suffer from social inclusion and the stigma around their impairment that influence their studies (Croft, 2020). As a result, visually impaired students lack support from educators and their peers. According to Lourens and Swartz (2021) able students do not relate with the visually impaired students in the same environment and the situation feels awkward for both students. The able students have their perception about the impairment or condition and isolate themselves. Matsei and Stofile (2021) emphasised that the inclusivity of stakeholders helps to institutional support, which increase the confidence of the visually impaired students.

Higher education institutions have disability units that attempt to address the needs of visually impaired students (Ndebele and Gadisi, 2022). The disability unit strives to support visually impaired students by converting learning materials into accessible format to enable them to progress normally with their studies (Amin et al., 2021). For example, materials are converted into braille and accessed with the relevant technology. Despite the support from the disability unit, students still face challenges with their learning environment, especially in STEM courses (Ndebele & Gadisi, 2022). In conformity, Lintangsari and Emaliana (2020) indicated that higher education institutions' policies must address the teaching and learning processes for visually impaired students without compromising any teaching standard.

Emphasis is on inaccessibility of higher education institutions' infrastructure and inadequate technology to support visually impaired students (Croft, 2020; Tom et al., 2020). The institutions have facilities to accommodate visually impaired students. However, these facilities are limited and some do not meet the required standard for visual impairment in practical courses (Amin et al., 2021). Where technology is available, students are unable to access or use it (Choi et al., 2022). According to Da Silva and Pimentel (2021) visually impaired students are struggling with mobility around campus to reach laboratories. Visually impaired students' mobility depends on orientation and training. Free and independent movement is restricted by architectural design. (Wulansari & Baharuddin, 2020; Yusof, 2020). All facilities must be easily accessible for visually impaired students to familiarise themselves with the environment (Ndebele & Gadisi, 2022). Lourens and Swartz (2021) emphasised that challenges faced by

visually impaired students in South African higher education institutions are still in existence. Inclusion in higher education institutions has never been easy for visually impaired students as they are confined to a smaller space and isolated (Zegeye, 2022; Lourens & Swartz, 2021).

The pressure is not only in the classroom, but also the environment and to adjust towards integration in higher education. Zegeye (2022) highlighted man-made obstacles that impact accessibility. Most higher educational institutions have never improved or changed their culture to focus on the advancement of inclusive curriculum for the visually impaired (Croft, 2020). Inadequate infrastructure makes visually impaired students to prolong their qualification, while some do not even complete (Wulansari & Baharuddin, 2020). According to Matsei and Stofile (2021), visually impaired students are discouraged from enrolling for certain courses, which limits their career choices and opportunities, especially STEM courses.

## 2.4 Visual impairment in higher education institutions

Seeing is not about information gathering but includes the important role of influencing individual motor skills (Lintangsari & Emaliana, 2020). Several studies indicate that visually impaired students are left behind because of their dependency, and that affects teaching and learning (Manitsa & Doikou, 2020). Visually impaired students are unable to manage the transition of teaching method from special school to public university with a diverse community.

In South African higher education institutions, visually impaired students go through the same admission process as able students and most of the students do not disclose their disability because of stigmatisation (Ndebele & Gadisi, 2022). The other reason not to disclose their disability status is fear of rejection (Negash & Gasa, 2022). According to Tekane and Potgieter (2020) it is not mandatory to disclose disability status. However, the status may assist the higher education institutions to provide support for the students accordingly.

### 2.4.1 Enrolment of visually impaired students

Higher education institutions recognise visually impaired students in their system. However, their enrolment is different from other students due to limited courses (Tom et al., 2021; Hu et al., 2019). Several studies indicate that career counsellors advise visually impaired students not to enrol for a wide range of courses, especially STEM courses. The limitation of courses affects higher education institutions globally (Lourens & Swartz, 2021; Hu et al., 2019). STEM courses are commonly known to be complex courses with practical subjects. Higher education institutions have started to enrol visually impaired students in STEM courses gradually.

Student representation in STEM courses is very low because most students share the same sentiment that STEM courses are difficult and require more vision (Hayes & Proulx, 2023; Choi et al., 2022). Visually impaired students who enrolled in STEM courses have not overcome

challenges in their studies (Tom et al., 2021; Adelakun, 2020). Visually impaired students solely depend on educators and peers to assist in running their experiments in the laboratories (Tekane & Potgieter, 2020). This includes assistance to complete other practical projects. The process is time-consuming, and students do not even visualise the final process of the experiment (Choi et al., 2022).

Learning mathematical and scientific concepts in STEM courses becomes difficult despite the upgraded braille and tactile devices to accommodate easy access and understanding (Ali et al., 2021). Visually impaired students who succeeded in their studies utilised different sensory inputs associated with the sense of touch through the support of the system compared to their sighted peers. (Koone et al., 2022; Mukhiddinov & Kim, 2022). Though the process is challenging, students receive extensive attention from dedicated academic teams (Tekane & Potgieter, 2020).

### 2.4.2 Challenges in accessing STEM

Many higher educational institutions need to improve, change their culture, and focus on the advancement of curriculum inclusion of STEM (Croft, 2020). The lack of facilities compels universities to limit the enrolment of visually impaired students in STEM courses and redirect them to social science courses (Ali et al., 2021). Higher education institutions have insufficient financial support to provide appropriate technologies to facilitate teaching visually impaired students in STEM courses (Amin et al., 2021). STEM uses visualisation as a medium of instruction, which reionforces the perception by most people that the visually impaired are unable to follow this medium of instruction (Mountapmbeme et al., 2022).

This includes how educators use visual techniques to facilitate lessons with graphs and diagrams (Tekane & Potgieter, 2021). Visually impaired students are always behind in incidental learning, especially with experiments. (Hayes & Proulx, 2023). The students are paired with sighted students to perform all the experiments. This discourages the visually impaired as they do not participate fully and lose interest in STEM courses (Wild et al., 2022). Educators also lack the experience to teach visually impaired students. As a result, both students and educators feel frustrated, and progress is slow (Schnepp & Watson, 2023).

STEM courses are highly demanding courses, and most educators are impatient and unwilling to go the extra mile for visually impaired students (Croft, 2020). Unequal treatment between sighted and visually impaired students still exists in the classroom and there are no strategies to overcome classroom barriers, which is highly recognised in STEM courses (Da Silva, 2020). Vision gives sighted students more advantage in STEM courses to assess equation problems immediately, while the visually impaired depend on instructions when accessing learning materials (Hahn et al., 2019).

In some cases, information is different from the real textbook where tactile devices do not pick up all graphics represented by data points (Tahiri, 2023). In this case, visually impaired students receive incomplete information that disadvantages their progress in STEM (Nashleanas, 2021). According to Tahiri (2023), visually impaired students find it difficult to follow instructions in laboratories because tactile facilities are incomplete, including clear instructions. In addition, space and furniture limit the sense of touch that is the main component of communication for the visually impaired (Yusof, 2020).

### 2.4.3 Consequences of challenges

The above-stated challenges are the main reason visually impaired students do not pursue STEM careers. Visually impaired students can detect the different approach between themselves and sighted students when educators outline instructions (Tahiri, 2023). Lack of appropriate materials and support make visually impaired students to develop the attitude and belief that they are incapable of breaking through in STEM courses (Bell & Silverman, 2019). The attitude from both educators and peers, including the stigma results in visually impaired students not enrolling in STEM courses (Hayes & Proulx, 2023). This includes the lack of safety and trust in laboratories. Wild et al. (2022) indicated that visually impaired students always need a partner during practical sessions in hands-on STEM courses. This discourages them from initiating experiments.

Higher education institutions do not have appropriate assistive technologies to support visually impaired students with their practicals, or proper training to utilise the facilities. Hence, these students avoid any STEM courses (Tom, et al., 2020). Accessing technical material is time-consuming and, most of the time, it is complicated. According Nashleansas (2021), students already in the course are forced to change course or not enrol STEM at all. Visually impaired students are very low in numbers in STEM courses because they drop out in the middle of the course (Schnepp & Watson, 2023; Zegeye, 2022). Students cannot handle the pressure of using incomplete information.

Several literatures indicate that challenges persist because students do not have appropriate assistive technologies (Zegeye, 2022; Tom et al., 2021; Bell & Silverman, 2019) Tekane and Potgieter (2021) specified inadequate support to utilise available tools and the lack of educator's experience and skills to facilitate teaching visually impaired students (Tahiri, 2023). According to Tom et al. (2021), visually impaired students are not exposed to STEM course because of their impairment. Akarsu et al. (2021) emphasised that visually impaired students need to work on one project multiple times before perfecting it, which makes them impatient. Discrimination in STEM classroom results in unsuccessful integration of students (McKinney

& Swartz, 2022). According to Koone et al. (2022), educators project class material in normal print format that excludes visually impaired students, and collaboration is a challenge.

## 2.5 Assistive technology

People with visual impairment depend on assistive technology to function and to develop independence. Ndlovu (2021) describes assistive technology as a product used by disabled people to promote their functionality in academia, social, and physical environments. According to Darabont (2020), assistive technology for visual impairment is very complex and has low-tech, mid-tech and high-tech haptic aspects. Assistive technology enhances the skills and individual performance of the visually impaired.

Visually impaired students use haptic materials to communicate (Koone et al., 2022). Kirboyun (2020) explained that low-tech assistive technology are non-electronic devices while high-tech are electronic. All tech devices bridge barriers in everyday life of visually impaired students. Techs are classified differently. According to Tuttle and Carter (2022), low-tech technology, like the braillewriter, is easily available and cost-effective with low or no maintenance needed. Midtech is digital and commercially affordable and maintenance is manageable with little training needed, and easy to use. Examples are adapted keyboards and digital recorders. Lastly, high-tech is complex, expensive, and training is needed for easy use, with high maintenance.

The devices function electronically. For example, Job Access with Speech JAWs or ZoomText software. Most students use high tech devices for accessing teaching and learning materials. Kirboyun (2020) emphasised that high-tech devices benefit visually impaired students through accessing both auditory and tactile methods. Despite the advancement of high-tech devices, visually impaired students experience difficulties in understanding STEM concepts, mainly in mathematics and graphics, including practical sessions (Maćkowski et al., 2023; Akarsu et al., 2021;). Visually impaired students use high-tech devices for easy internet access and to process speech to text or vice-versa, using braille. Braille is the language used by the visually impaired to read and write.

According to Ali et al. (2021), braille utilises six dots to form alphabets. Braille dots make sentences that the visually impaired can read without any aid. Braille six dots have been upgraded to eight dots to function as high-tech to facilitate STEM teaching (Wahab et al., 2021). However, not all assistive technologies are seamlessly compatible with braille. According to Ali et al. (2021), visually impaired students encounter difficulties with braille regarding the limitation in accessing diagrams and mathematical graphics despite the eight dots upgrade.

There is increasing emphasis that graphics on screen readers are still inaccessible by visually impaired students because its focus is mainly on text (Kruger et al., 2020). Access to these technologies is complex because of the knowledge and skill needed to use it; hence, it is necessary to develop criteria to select the most appropriate ones within the context. The following are high-tech assistive technologies used by the visually impaired.

### 2.5.1 Types of assistive technology

Currently, there are several assistive technologies, which contributes to the confusion in their selection and adoption. This includes Screen readers, Augmented reality (AR) and Virtual reality (VR) technology, OrCam MyEye, The Internet of Things (IoT), and Artificial intelligence (AI) technology. A review of the technologies is conducted in the context of this study.

- Screen readers

People with visual impairment have the advantage of using computer applications through assistive technology. There are many different types of screen readers applicable for usage by visual impaired people. The following are commonly used: screen reader, Job Access with Speech (JAWS), NVAD, Android TalkBack and Apple VoiceOver. All are compatible; however, JAWS is one of the popular screen readers that enable the visually impaired to use computers independently. According to Ndlovu et al. (2023), JAWS is a computer application with speech output and braille used by people without vision.

JAWS works normally like a computer despite the challenge of being unable to interpret images. According to Kruger et al. (2020), visually impaired users navigate computer applications through audio and braille, and technology reads the screen display. People living with visual impairment develop good listening skills to gather all information from the audio. The users of screen reader always need more time to scan the content of the web page in contrast to sighted users. They scan a page in seconds (Dabi & Golga, 2023). Figure 1.1 below depicts how screen reader works for easy use by visually impaired people.

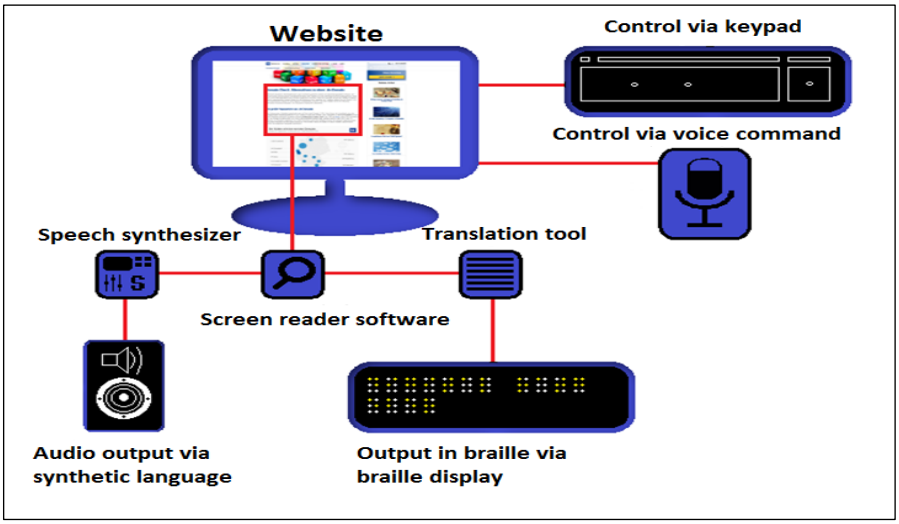


**Figure 2.1: IONOS screen reader (2018)**

- Chart Visualizations (ChaVis)

ChaVis uses maths and graph to assist visually impaired students to come cope with complex data. According to Kim et al. (2023) CharVis needs tactical display to read and interpret data. CharVis separates data from displayed charts and graphs. Raw data extracted from CharVis is presented in an understandable format for the visually impaired (Singh et al., 2023). Visually impaired people need extensive training to understand CharVis, and the main challenges with CharVis is that main screen readers and braille cannot extract any information from it (Singh et al., 2023).

- Augmented reality (AR) and virtual reality (VR) technology

AR and VR are the technologies that empower visually impaired people to be independent. These technologies use electronic glasses (E-glasses) that have camera and audio to enable eyesight for both low vision and total blindness (Waisberg et al., 2024). The glasses are part of meta devices that use AR and VR to grant the visually impaired the opportunity to detect any object and display it in 3D in real time (Waisberg et al., 2024). E-glasses give visually impaired people better vision. Rayban eye wear is part of AR devices. According to Iqbal and Campbell (2023), Rayban can make calls and send messages through Facebook Messenger via voice command. Rayban stories are powered by artificial intelligence (AI) to capture each real time moments (Iqbal & Campbell, 2023).

Acesight is another type of E-glasses powered by Zoomtex. Acesight uses glasses like binoculars. They are bigger to cover full eyesight, giving the visually impaired comfort to use their heads to control and have different views of the environment (Schipor & Aiordăchioae, 2020). Figure 2.2 below depicts the different types of E-glasses.


**Figure 2.2: Rayban stories (Iqbal & Campbell, 2023) Acesight electronic glasses (Schipor & Aiordăchioae, 2023)**

- OrCam MyEye

OrCam is an assistive technology that assists the visually impaired to perform different tasks in their daily lives. Nguyen et al. (2022) define OrCam as a camera device that translates text into speech and accommodates all levels of vision loss. OrCam is empowered by artificial intelligence (AI) and machine learning. The device has 8MP picture quality that captures any text and object and translate it into speech to assist visually impaired people and the totally blind to function independently (Granquist et al., 2021). OrCam Pro can identify colours and read barcodes to allow the visually impaired to shop on their own without any assistance. The device enables them to recognise faces and is controlled through a tiny button or verbal instruction (Granquist et al., 2021).

**Figure 2.3: OrCam MyEye (Nguyen et al., 2022)**

- The Internet of Things (IoT)

IoT is an innovative tool that acts as a third eye to visually impaired people. Bouzidi et al. (2023) describe IoT as a solution to overcome any obstacle around visually impaired people through a notification. Elksasy (2023) defines IoT as “a network that connects uniquely identifiable ‘things’ to the internet.” The solution is a wearable device that improves the life of visually impaired people, socially and personally in their own space. According to Bouzidi et al. (2023), IoT uses radio frequency identification (RFID) to communicate, including electronic

sensors and QR codes. IoT provides voice command and feedback to manage the needs of visually impaired people with motion sensor for easy navigation. Deepthi et al. (2023) emphasised that the technology can communicate dangerous environment to visually impaired people and alert their close contacts. The alert is presented in different sounds to differentiate the danger. The technology gives visually impaired people artificial vision (Elksasy, 2023; Deepthi et al., 2023). Figure 2.4 below illustrates the IoT.

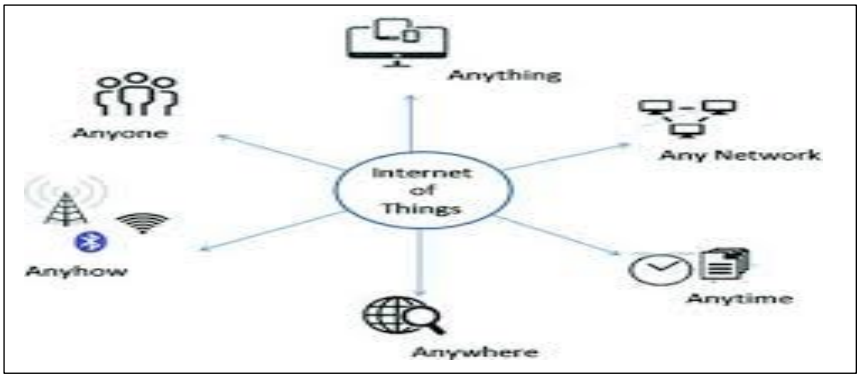


**Figure 2.4: The Internet of Things (IoT) (Elksasy, 2023)**

- Artificial intelligence (AI) technology

AI technology opens a new door for visually impaired people by eliminating many restrictions that affected them. Sheikh et al. (2023) define AI as "systems that display intelligent behaviour by analysing their environment and taking actions with some degree of autonomy to achieve specific goals." AI provides visually impaired people opportunities to access what was previously inaccessible. Mahalingesh et al. (2023) describe AI as an imitation of human capabilities to perform complex tasks by using the computer effortlessly. AI develops human behaviour in every task and helps to be familiar with the surrounding environment (Sheikh et al., 2023). Visually impaired people can use the technology to recognise familiar faces without any assistance (Mahalingesh et al., 2023). AI can assist in converting daily obstacle into audio. AI created a Vivid app that is used by visually impaired people through gestures and voice output to complete tasks in a single camera (Alhazmi et al., 2022). AI powered devices will reduce challenges faced by visually impaired in higher education institutions.

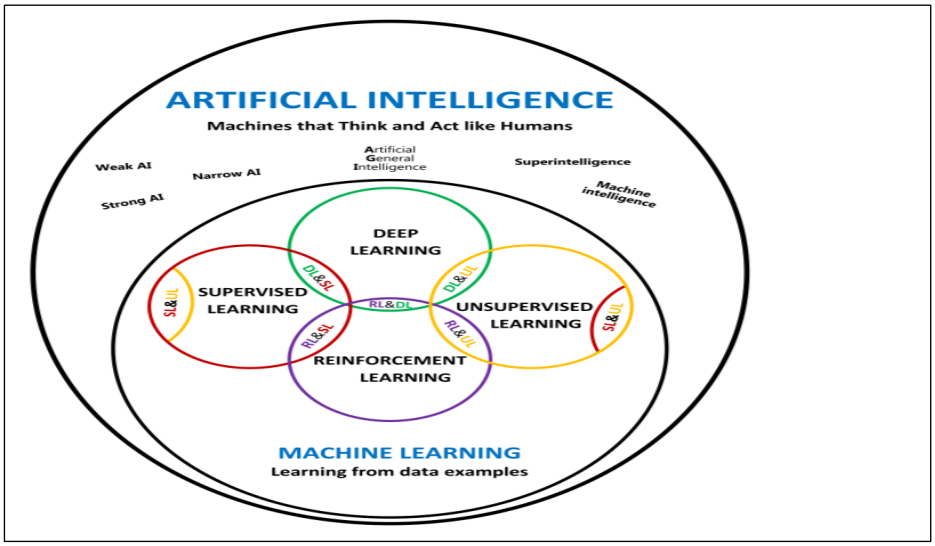


**Figure 2.5: Artificial intelligence (Jean-Claude, 2022)**

## 2.6 Technology adoption

Technology adoption is more about how new technology is applied. According to Hooks et al. (2022) technology is new knowledge that one acquires to perform tasks differently and easily. Digital transformation accommodates all organisations that need to adopt innovation. As technology evolves, there is a strong need for organisations to transform. There are three components that impact the adoption of technology; technological, organisational, and environmental (Ismail & Jokonya, 2023). Technologically, organisations must be ready to adopt the technology that will address organisational strategy and performance needs.

The cost involvement around the technology impacts the organisation in terms of adopting the proposed technology immediately. Specialists are the relevant people to provide advice during adoption. Organisationally, the organisation should be ready to adopt the new system, including how processes are followed within the structure to achieve organisational objectives. Environmentally, the organisation must operate competitively to adopt the technology that maintains and stores organisational policies to be shared as needed. Management can resist the adoption decision if there is no value added to the company.

## 2.7 Underpinning theories

This study focused on two theories, which were used as a lens to underpin the study. The two theories are Diffusion of innovation (DOI) and Contingency theory (CT). The two theories were selected based on the following objectives of the study.

I. To identify factors that can guide the selection of the most appropriate assistive technology for visually impaired students in practical sessions or classes.
II. To determine the factors that could influence the use of assistive technology by visually impaired students and those supporting them.

III. To provide guidelines on how to apply the assistive technology framework by visually impaired students and those that support them.

These theories complemented each other to achieve the aim and study objectives. DOI examined how assistive technology was employed to enable and support visually impaired students, while CT was employed to interpret the findings.

### 2.7.1 Diffusion of innovation

Diffusion of innovation is a theory originated by Rogers around 1962. The theory has been implemented in various areas of research. The focus of the diffusion of innovation theory is mainly to establish how new or modified existing technology can be spread (Rogers, 2003). Diffusion is a social process. Rogers (2003) defines diffusion as “the process in which an innovation is communicated through certain channels over time among the members of a social system” and innovation as “an idea, practice, or project that is perceived as new by an individual or other unit of adoption”. DOI is related to the adoption of any technology. Iyamu (2021) emphasised that adoption is a decision initiated from ideas.

DOI supports the spread of innovation amongst individuals in a social system (Keitany et al., 2020). A decision can be acceptable or rejectable. Where accepted, innovation may end up not being adopted depending on the system and situation. Innovation or technology is a new concept to be diffused (Keitany, Munyi & Muthee, 2020). García-Avilés (2020) emphasised that diffusion is another form of communication where individuals share a common understanding. However, individuals develop uncertainty along the communication line. Rogers et al. (2009) indicated that diffusion is more of interpersonal communication. Attributes of innovation highlight uncertainty through sharing more information. The overall DOI reduces uncertainty (Das, 2022). Users of the system develop uncertainty about how innovation will benefit the entire project. The definition of diffusion highlights the innovation and communication through channels, over time, and among members of a social system. These highlights build up the four elements of diffusion of innovation (Rogers, 2003). The four elements influence the spreading of new ideas (Carl & Herber, 2021).

1. Innovation

Innovation is a new or existing idea that is modified and perceived as new by individuals and groups in the organisation according to the level of adoption (Das, 2022). Iyamu (2021) emphasised that innovation does not only refer to new knowledge but to the existing technology that needs enhancement. People may develop attitude towards innovation before even adopting or rejecting it. Rogers (2003) identified five attributes of innovation with the main purpose of influencing the rate of adoption. The attributes are relative advantage,

compatibility, complexity, trialability and observability. Table 2.1 below explains the different attributes of innovation as described (Rogers, 2003; Rogers et al., 2009).

**Table 2.1: Attributes of innovation, adapted (Roger, 2003)**

| Attributes | Definition |
|---|---|
| Relative advantage | Innovation is considered as beneficial as compared to the current technology in use. Elements that confirm relative advantage in the process of adopting innovation is cost involvement and how users perceive the adoption. Relative advantage of innovation can be overrated during adoption. |
| Compatibility | The technology fit into the current practice, where users evaluate the system according to their previous experiences and values. Innovative technology must address the initial challenges to eliminate the uncertainty for smooth adoption. |
| Complexity | Complexity is when the technology is perceived as difficult to use and users are reluctant to adopt it. Users can adopt technology and later reject it because of the challenges in use. |
| Trialability | Is a process of trial of how technology works on a small scale to reduce uncertainty before adoption. The trial experience fastens the decision to adopt the technology and allows modification where necessary. |
| Observability | The end results have an impact on adoption and users observe and be motivated to adopt the technology. |

2. Communication channels

Communication channels are platforms where individuals or groups share available information with one another to reach common goals (Carl & Herber, 2021; Wani & Ali, 2015). The channels involve the exchange of information in different formats from one person to different people (Iyamu, 2021). The exchange of information can happen both virtually and in person. Channels are also related to the communication that changes individual attitude towards the innovation.

3. Time

Time has an impact on the process of diffusion. The importance influences the allocation of time, based on which individuals process and adopt or reject the new information (Rogers. 2003). Time has the following aspects of innovation – decision process, innovativeness, and rate of adoption of innovation.

i. Innovation – decision process

Innovation decision process is important to facilitate the stages or processes of adoption from information seeking to the final innovation decision. This process reduces the adoption uncertainty (Rogers et al., 2009). The adoption is not secured because it can be rejected after the final stage. The innovation-decision process follows five stages identified by Rogers (2003). The diagram below illustrates the stages of the innovation-decision process.

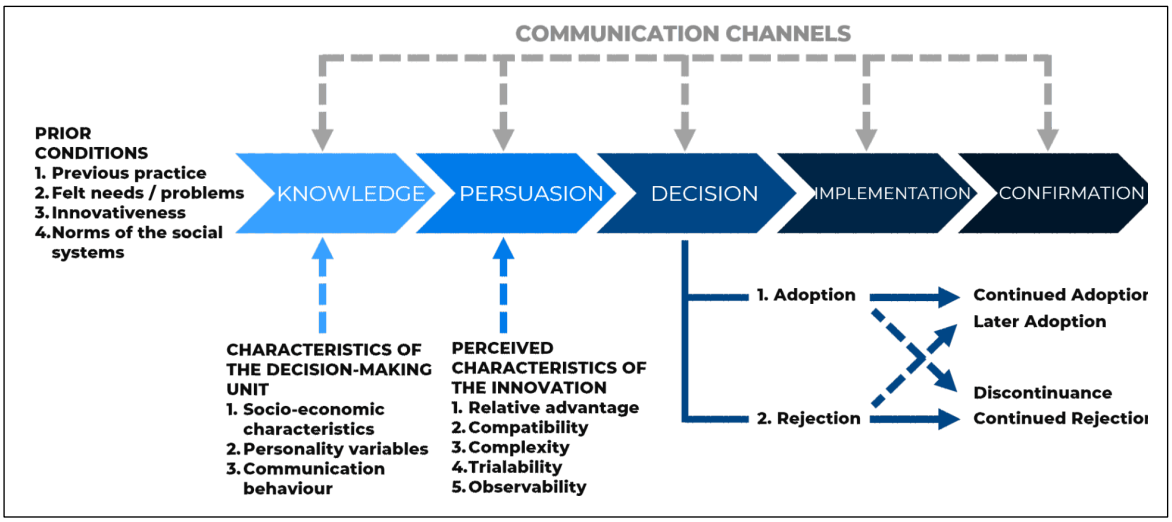


**Figure 2.6: Five stages of innovation-decision process adopted by Rogers (2003)**

a) Knowledge stage: is the first stage in the innovation-decision process. Individuals and group units need to learn and have extensive knowledge about the innovation. This stage gives individuals the opportunity to enquire more about innovation with the questions relating to “How, What and Why” (Iyamu 2021; Rogers et al., 2009). The information is transferred through communication channels. Individuals acquire more knowledge about innovation and associate it with their needs.

b) Persuasion: is more about the uncertainty of innovation, where individuals and units tend to adopt or reject the innovation. The more people advocate for the innovation, the more it reduces uncertainty (Donmez-turan & Zehir, 2021). Individuals seek relevant information about the innovation from trusted sources and develop more positive attitude and perception towards it.

c) Decision: is where individuals and decision makers take a decision to adopt or reject innovation (Roger, 2003). A trial assists in the decision making and to identify the advantages and disadvantages of the innovation that makes decision easier. The trial reduces the uncertainty about adopting innovation.

d) Implementation: the innovation is in use and individuals change behaviour around the importance of adopting the innovation (Rogers, 2003). More information is required to complement the easy use.

e) Confirmation: is all about continuation of using the innovation. It is reassurance of the decision taken to continue or reject innovation (Makovhololo et al., 2017). Activities confirm the usage, and more information is gathered for better understanding.

ii. Innovativeness

Individuals or units operate differently in the manner they adopt new ideas. According to Rogers (2003), innovativeness is based on earlier adoption than others. Each adopter has a different understanding following their time of adoption (Fujii, 2022). Based on innovativeness, there are different levels of adoption, from immediate to late adopters, depending on how innovation is perceived over a period (Fujii, 2022; Rogers, 2003). The adopters differ according to their uncertainty about innovation. According to Carl and Herber (2021), adoption begins at a lower rate while individuals and social systems are in the processes of learning the adoption of innovation.

The S-curve demonstrates how different people react to innovation at a time (Carl & Herber, 2021). Adopters are classified into five categories to use the technology. The diagram below depicts phases of adopters in the process of innovation. The S-curve is the cumulative diffusion curve and the bell curve represents new numbers of adopters at a time (Carl & Herber, 2021; Rogers, 2003).

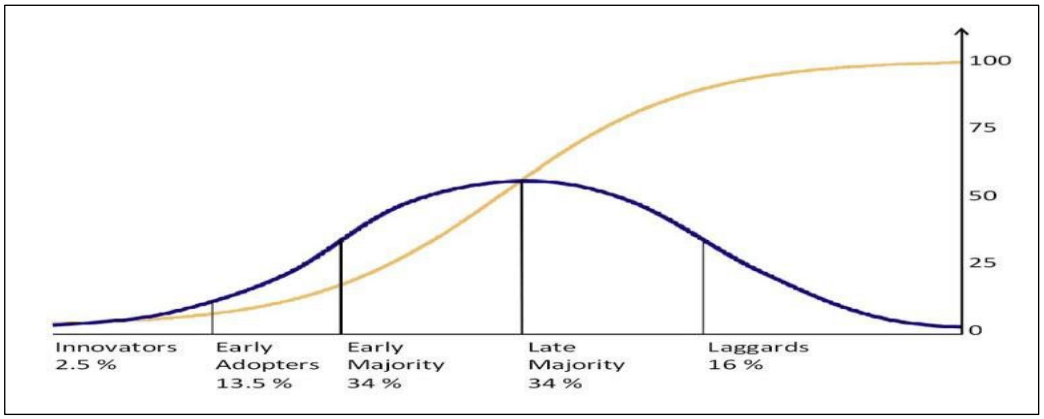


**Figure 2.7: The s-curve and bell-shaped adoption curve adopted by Rogers (2003)**

Innovators are risk takers who adopt technology that might fail at a later stage. Early adopters have knowledge and confidence in innovation (Wani & Ali, 2015). Individuals that adopt innovation in the early stages decrease uncertainty. The early majority take time to adopt innovation and they are followers in terms of leading the adoption. The late majority are indecisive about the innovation (Carl & Herber, 2021). The laggards tend to prolong activities until the social system adopts, and they will follow with persuasion. The laggards come last in adoption. The laggards are more traditional and believe in the program that is running before they adopt any innovation (Ramdhani et al., 2021).

iii. Rate of adoption of innovation

The rate of adoption of innovation focuses on the speed of innovation adoption. The adoption is based on social systems and the time required (Das, 2022).

### 2.7.2 Diffusion of innovation and information systems

Information systems (IS) and information technology (IT) change rapidly to be aligned with the current trends. The IT industry introduced advanced technology to accommodate the changing needs in the social systems. Innovation focuses on bringing new ideas by improving the existing ones (Makovhololo et al., 2017). The transition from old to newer systems is a form of innovation. Diffusion is the spread of innovation amongst users through communication channels that need an understanding from the social system (Rogers, 2023). The diffusion in the context is to select the appropriate technology that will assist visually impaired students with their practical classes. The innovative technology must be compatible to accommodate visually impaired students and manage their challenges (Donmez-turan & Zehir, 2021).

DOI allows organisations to adopt the relevant technology that guides the strategy to be competitive. Information related to the new technology is diffused through stages of communication channels for better performance (Rogers, 2003). The social system or community has the power to reject or adopt innovation through certain levels, according to their understanding (Fujii, 2022). According to Donmez-turan and Zehir (2021), early adopters have an impact or persuade other members of the social system to agree and increase the level of adoption. DOI can bring change into organisational strategies by implementing innovative technology for sustainability.

Different studies have applied DOI successfully, for example, in the health sector, where practitioners use E-health in accessing real time information of medical records remotely and offer services without being present (Putteeraj et al., 2022). The adoption of E-health reduces the records duplication and multiple prescriptions to patients in different medical depots. In the educational environment, most higher education institutions have implemented the fourth industrial revolution (4IR) and artificial intelligence (AI) that include the transition of e-learning to reduce teacher- students ratio by integrating immediate communication through chatbots (Lubinga, et al., 2023). DOI is also used to identify some of the gaps that are still available in the full adoption of (4IR) and (AI) in the education sector.

The application of DOI in the information technology industry and academic environment has impacted the decision to enhance their services. DOI gives this study a competitive advantage of not limiting visually impaired students by diffusing information through communication channels. Visually impaired students perceive innovation as a tool to access STEM courses. The more information is spread about the innovation, the more it leads to early adoption. This

helps to eliminate the uncertainty that visually impaired students are not illegible to progress with STEM courses.

### 2.7.3 Contingency theory

Contingency theory (CT) is the theory related to how organisations fit the environment to perform better. CT was discovered by Fiedler around 1964. It categorised effective leadership style. Fiedler (1964) argues that through CT relationship can be built to determine the successful performance of an organisation. Donaldson (2001) defines contingency theory as a "variable that moderates the effect of organisational characteristics on organisational performance". CT emphasises leadership style and behavioural orientation based on the environment (Miller, 1988). The environment is a perfect description to determine the uncertainty of the organisation from the external factors (Donaldson, 2015).

The uncertainty of the performance outcome can be predicted from both internal and external influences in the organisation. According to Freeman (2015) uncertainty begins within the environment in reaction to innovative technology that is introduced to do things differently. Donaldson (2015) stated that innovation and structure have more impact on uncertainty to allow the perfect fit. Organisational rules and structure can influence uncertainty. Donaldson (2015) indicated that structure can have multiple misfits that affect performance. Bets (2003) emphasised that organisational structure can be complex. However, it is possible to identify misfit to enhance performance.

CT states that the way organisations operate differs from one another with different characteristics. Bets (2003) indicated that size, technology and culture within the environment are factors affecting contingency for a better fit. According to Harney (2023), CT must be aligned with the external and internal factors because of its influence on organisational functionality. The organisational structure and strategies inform high level performance to achieve objectives. Iyamu (2021) emphasised that CT encouraged leaders to focus on the effectiveness of the organisation for a better fit. Miller (1988) identified the concept that strategy has more control over the environment for organisations to fit better.

The strategy is unable to operate without depending on the structure to match the environment and produce better performance (Blanton et al., 1992). According to Miller (1988), there is a good relationship between structure, strategy, environment, and performance, as themes that drive the organisation to success. Blanton et al. (1992) followed the concept of the relationship of themes from Miller's perspective. The adoption of four components emphasised the success of organisations to a better fit. Blanton et al. (1992) illustrated the relationship of themes from CT perspective in the figure below. The four components highlight the contingent relationship.

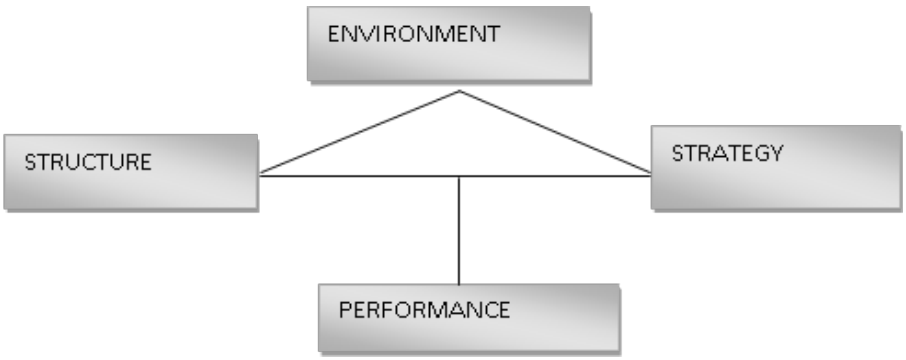


**Figure 2.8: Contingency Model (Blanton et al., 1992)**

Organisational structure is a level of reporting for employees to ensure that the organisation functions according to their objectives. The structure informs the organisational strategy to ensure better fit and performance (Blanton et al., 1992). According to Iyamu (2021), each component has special characteristics that direct a better fit to escalate performance. Complex structure is capable of insecurities. Strategy, when aligned with structure, has the contingency to be flexible. According to Mashilo and Iyamu (2011), strategy develops sustainability in the organisation to make it competitive. The four components fit each other for greater performance.

The environment is the key area where all activities are operated to secure better performance towards a perfect fit (Bets, 2012). The key elements of CT distinguish the relationship between success and failure of organisational fit (Iyamu, 2021). Leadership style is the focus area to determine the success of the organisation through the strategy and structure that fit the organisation perfectly. There is no specific rule in contingency to govern the organisation. The lack of structural contingency influences organisational structure that has multiple divisions. This builds up uncertainty (Donaldson, 2001; Donaldson, 2006). The structural division must fit in to produce high performance. In contrast, misfit produces low performance (Donaldson, 2015). Donaldson (2001) indicated the following three core elements to achieve organisational objective.

- The relationship between contingency and organisational structure

The relationship between contingency and organisational structure is based on the same vision within the common environment. The relationship also broadens the spectrum of achieving greater results in a favourable environment that allows better fit. Iyamu (2021) indicated that organisational structure depends highly on information technology to support internal and external factors to reduce uncertainty. Information technology does not predict outcome but assists managers to take control and focus on performance.

- Contingency change causes organisational structural change

The contingency is associated with organisational structure because of the constant changes within the structure. A change in contingency directs the organisational structure into misfit and allows performance to deteriorate. Performance improves according to the positive changes of structure over a period (Husted, 2000). The organisation starts to restore performance with a perfect fit after the implementation of the new structure. Managers encourage change and align the new structure to increase performance. Information technology restores effectiveness along the contingency.

- Fit affects performance

The perfect fit that enhances performance is associated with a good organisational structure and contingency. Good performance is about structure and contingency to satisfy both internal and external stakeholders. Fit or misfit of organisational structure is based on how processes are implemented towards a sustainable performance (Husted, 2000). Organisations stipulate their objectives according to the structure in achieving better performance that fits the diverse contingency. Misfit allows structure and contingency to fall behind. Organisations strive to move from misfit to fit to show improvement in performance and achieve stipulated objectives.

### 2.7.4 Contingency theory and information system

Information technology is the key driver to facilitate organisational processes to achieve business objectives. According Pearlson et al. (2024), information system (IS) is a “set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision-making and control in an organisation to achieve goals”. Contingency theory (CT) focuses on the perfect fit in the organisation, whereas IS aims at achieving organisational objectives (Donaldson, 2015). The fit or misfit in CT is influenced by the correct selection of IS that support managers to take decision in implementing solutions. Organisations with a perfect fit employed proper systems to achieve organisational objectives.

Organisations operate differently within CT as there is no one solution for all the processes and circumstances. Managers are contingent to the situation or environment. The environment is favourable with the selection of suitable systems to have a better perfect fit (Husted, 2000). The changing need of structure and strategy affect performance, and managers fall into a complex situation with the technology that is non-functional. The technology that is not aligned with the structure and strategy will affect performance. The managers have options to select technologies that enhance implementation and governance for better fit. Iyamu (2022) emphasised that IS technologies can change the usage of CT in different spectrums.

The benefit of CT in IT/IS studies is related to the flexibility with which change is embraced by the leadership in response to be crisis faced by the organisation due to the upgraded

technology. The innovative systems have an impact on the downfall of the organisation from the consequences of the rigid structure. The best fit of IT/IS systems operates seamlessly in improving productivity and performance from the team and reduces uncertainty (Iyamu & Tunzelana, 2016). Good communication skills from management allow the team to be multi-skilled and operate efficiently in terms of restructuring. CT encourages the relevant leadership to accept innovative ideas and adopt the new technologies that will improve organisational strategy and performance (Iyamu, 2021).

Contingency theory has been used in different sectors. In the manufacturing environment, CT was applied to drastically adopt AI machinery in the field to ensure external competitive advantage. The emphasis is that there is no one approach that fits all business strategies for sustainability (Romero-Silva et al., 2022). As a result, the manufacturing sector changes strategy for a perfect fit to improve performance. In the IT/IS sector, there is a constant implementation of new strategies to improve performance because of the risk and new opportunities around the latest technology (Ali et al., 2021). CT focuses on the perfect fit where there is no “one size fits all” leadership characteristics (Miller, 1992). The perfect fit in IT/IS embraces how new technology impacts the organisational structure to enhance performance for sustainability (Yusuf et al., 2023).

### 2.8 Diffusion of innovation and contingency theory

The origin of both theories was not meant for IT/IS. However, their application has been successfully implemented (Iyamu, 2022). The two selected socio-technical theories complement each other in this study to identify the appropriate technology for visually impaired students and the strategy that can transform the usage to achieve better fit.

#### 2.8.1 Order-of-use

DOI as a lens was used first because of its relevance to the selection and adoption of the available technology to assist visually impaired students in their practical sessions. The importance was to understand the available new technologies first before combining them with other theories. This included how this technology will assist visually impaired students to achieve their objective in the practical sessions.

CT followed as a strategic phenomenon that depends on the environment to perform successfully. However, CT strongly emphasised that there is no single option to manage different circumstances. That is the main reason for CT and to interpret findings and align management strategy to the selected environment with the most appropriate assistive technology. The choice of better fit results in the adoption of change with a remarkable performance.

## 2.9 Summary

This chapter reviewed the literature related to the objective of this study about visual impairment, the challenges of visual impairment, higher education and visual impairment and the challenges and consequences faced by visually impaired students in relation to the enrolment of STEM courses with practical subjects. The two socio-technical theories, diffusion of innovation and contingency theory, were selected based on their proper fit to the study. DOI and CT were applied in the data analysis and interpretation of the findings, respectively.

# CHAPTER THREE
# RESEARCH METHODOLOGY

## 2.10 Introduction

This chapter focuses on the research methodology applied in this study. The methodology was guided by the aim and objectives of the study to develop an assistive technology framework for visually impaired students for learning purposes in practical sessions or classes in higher education institutions in South Africa, as stated in Chapter 1. The methodology covers the philosophical assumption that underpins the study, research approach, research methods, research strategy and research design.

The chapter is organised into nine main sections. The first two sections discuss the philosophical assumption and philosophical stance. The three sections that follow are the research approach, methods, and design respectively. In the sixth and seventh sections, how data collection and data analysis including interpretation of the findings were conducted are discussed. The eighth section focuses on the ethical considerations followed through the study. Lastly, the summary is covered in section nine.

## 2.11 Overview of the underpinning theories

Philosophical assumption is about beliefs and assumptions of what exist in the real world and how to view this existence in different ways or formats (Rowe, 2018). Research philosophy is based on the set of beliefs and assumptions of what is known in the real world, which is knowledge acquired (Saunders et al., 2019). These beliefs and assumptions inform how to conduct a research. There are different philosophical elements. However, the two popular elements used in information systems is ontology and epistemology (Creswell & Creswell, 2022).

The two elements complement each other, and researchers cannot choose one over the other. However, all elements in the philosophical assumption are important to guide the research process in selecting the appropriate method of the study (Leedy & Ormrod, 2021). Figure 3.1 below depicts the relationship of all the elements in philosophical assumption adapted from Brown and Duenas (2020).

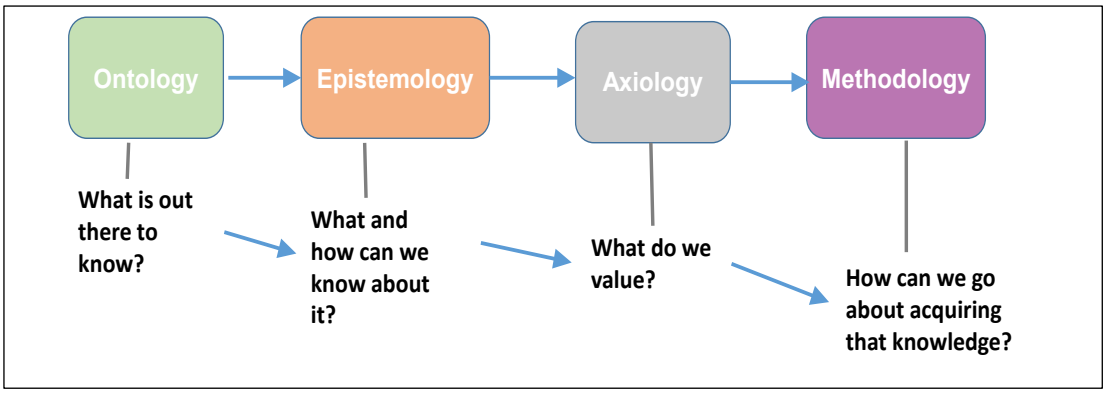


Figure 3.1: Relationship of elements of philosophical assumption (Brown & Duenas, 2020)

### 2.11.1 Ontology

Ontology refers to the nature of many realities with different characteristics that exist in the world (Yulianto, 2021). Reality is the existence in real world with different meanings and understanding in different disciplines. Despite how ontology can be used, it remains the social reality around that phenomenon. According to Handema et al. (2023), ontology can be viewed as subjective, which means reality is based in the mindset of a researcher while an objective perspective is where reality is observable. Moroi (2020) confirmed that many realities are through nature and structure relating to individual perspectives. Ontology gives the research a direction to make sense of the reality of a phenomenon.

Ontologically, in this study, the researcher embraces many realities that visually impaired students exist, and these students have challenges with courses that have practical subjects (Lourens & Swartz, 2021). The second reality is the assumption that visually impaired students depend on assistive technology to undertake their daily tasks, including academic support (Tom et al., 2021; Lourens & Swartz, 2020). The other challenge is to identify the most appropriate technology that can support visually impaired students with practical classes. These challenges progress to epistemology in this study. This is the main reason the two elements in philosophical assumption cannot stand separately.

### 2.11.2 Epistemology

Epistemology is the study of uncovering knowledge and belief (Saunders et al., 2019). Epistemology emphasises what can be learned from what ontology confirmed about the existence of realities (Yulianto, 2021). Epistemology is the creation of meaning and understanding of the concept that is being studied (Al-Ababneh, 2020). The nature of knowledge depends on the level of understanding to acquire more knowledge (Muchanga, 2020). The importance of epistemology is more on confirming what is already known, which is subjective, through research (Saunders et al., 2019). For example, the researcher can identify a problem and investigate it through research processes to confirm whether the nature of knowledge is true and to gain more knowledge.

Epistemologically, this study is on learning more about factors that guide the selection of the most appropriate assistive technology for visually impaired students during their practical classes and acquire more knowledge about these factors. Knowledge is gained through subjective experience in a real setting to increase the level of understanding.

### 2.11.3 Axiology

Axiology focuses on social values and ethics in the environment (Saunders et al., 2019). Axiology is related to the principle of doing right or wrong, which may be sometimes biased. Axiology is about human values on performance in a particular situation following one's action in social conduct (Moroi, 2020). According to Yulianto (2021), axiology is more on the Why question to understand the processes of achieving certain standards. It also focuses on the What question to address what should be done ethically to interact with participants to achieve research objectives (Moroi, 2020). Philosophically, this study does not focus on any social values and ethics.

### 2.11.4 Methodology

Methodology is also referred to as philosophy of methods (Creswell & Poth, 2017). Methodology is about research design, method, and procedure to achieve the objectives of the study. Methodology informs the selection of a specific method or action plan within the research study. Saunders et al. (2019) emphasise that methodology is the roadmap on how to collect data and analyse it to achieve the outcome of the research. Thus, it is how a clear understanding of ontology and epistemology aligns with the choice of the correct methodology (Creswell & Poth, 2017). Methodology mainly includes qualitative, quantitative and mixed methods that the researcher may select to guide the process (Moroi, 2020). Quantitative approach is associated with deductive reasoning while qualitative approach is inductive reasoning (Saunders et al., 2019). The qualitative approach seeks to understand the phenomenon under investigation through subjective enquiry to generate new knowledge (Creswell & Poth, 2017). Mixed method is the combination of the qualitative and quantitative methods, which strengthens the outcome of the study.

## 2.12 Philosophical stance

Philosophical stance outlines the direction of the study (Handema et al., 2023). The philosophical stance forms a base on how knowledge can be attained. The focus on a stance is important because it has an impact on the research approach (Cresswell & Poth, 2017). A stance is about belief that puts assumption into practice in IT/IS (Schultze et al., 2020). The following are the popular stances used in IT/IS; positivism, interpretivism and pragmatism. Different stances are briefly described below.

### 2.12.1 Positivism

Positivism as a stance believes that there is one reality that is observable and measurable to obtain a clear understanding (Leedy & Ormrod, 2021). Positivism focuses on a pure scientific and statistical methods through experiments, measurable facts, and observations that reveal credible and meaningful data (Junjie & Yingxin, 2022). Positivism is associated with quantitative methods and deductive approaches. That means findings can be quantifiable and measurable (Saunders et al., 2019). Positivism supports that reality exists and must be objective without being biased. Positivism is systematic and is formed from a set of structures and rules (Leedy & Ormrod, 2021). Ontologically, positivism believes that one reality affects individuals the same way (Saunders et al., 2019). This study does not require measurement or observation of any sort. Therefore, the positivism stance is not aligned with the ontological and epistemological assumptions of this study, which is subjective.

### 2.12.2 Interpretivism

Interpretivism is an in-depth enquiry focusing on any understanding of meanings associated with experience, thoughts, views, and feelings of actors' reality (Junjie & Yingxin, 2022). According to Alharahsheh and Pius (2020), interpretivism differentiates physical phenomenon and humans when creating meaning to the concept. Interpretivism is known as constructivism because it allows individuals to construct meaning in their natural setting (Junjie & Yingxin, 2022). Interpretivism is influenced by phenomenology, which is subjective (Lim, 2023). The subjectivism is associated with the collection of data in real settings where individuals express their views and experiences. Data collected is analysed to find proper meaning (Babbie, 2021). Interpretivism is qualitative based on how people explain and understand their reality in a social context (Coates, 2021). Ontologically, interpretivism is relativist as it perceives meaning from complex data. From a subjective perspective, this study sets to understand how to select appropriate assistive technology for visually impaired students for courses with practical subjects.

### 2.12.3 Pragmatism

Pragmatism focuses on the nature of experiences and science (Saunders et al., 2019). According to Alharahsheh and Pius (2020), pragmatism believes in many realities to interpret the real world. Human action cannot be separated from past experience and beliefs. Therefore, pragmatism is in agreement that the world or realities are static (Kaushik & Walsh, 2019). Pragmatism has the effect of multiple explanation and interpretation of concepts which uses both interpretive (qualitative) and positivist (quantitative) approaches as a mixed method (Saunders et al., 2019). A mixed method covers both the understanding and experiences of participants as well as quantifying the process. The pragmatic approach supports the combined methods depending on how research questions and objectives are addressed. Pragmatism confirms that reality exists and happens through human experience (Al-Ababneh, 2020). That is the reason the pragmatic stance is not suitable for this study.

## 2.13 Research approach

The choice of philosophical stance determines the approach. Research approach is a technique used to conduct a study (Handema et al., 2023). IT/IS uses three different types of approaches, namely deductive, inductive, and abductive approaches. However, the most common approaches are deductive and inductive, which are discussed in this study. These approaches complement each other. The objectives of the study determined the correct approach whether is to test theories or develop new theories.

Deductive reasoning is used in quantitative method to test an existing theory (Saunders et al., 2019). It is mainly associated with the positivism stance. Deductive reasoning starts at the top; it is top-bottom. This means it starts from general to specific (Gupta et al., 2022). The researcher uses available data that is quantified and measured to formulate the hypothesis through observation or experimentation (Saunders et al., 2019). The testing might be true or false. A deductive conclusion may be generalised based on the outcome.

Inductive reasoning is used in qualitative method and its main aim is to develop new theories (Saunders et al., 2019). Inductive reasoning starts from the bottom and is known as bottom-up. The inductive approach explores new theories through observation or interviews to recognise patterns and relationships to generate meaning (Handema et al., 2023). The data collected is categorised according to themes to form new theories (Gupta et al., 2022). Inductive reasoning is flexible, and the focus is from a specific premise to a general conclusion. Figure 3.2 below illustrates different phases in both inductive and deductive reasoning, adapted from Burney and Saleem (2008).

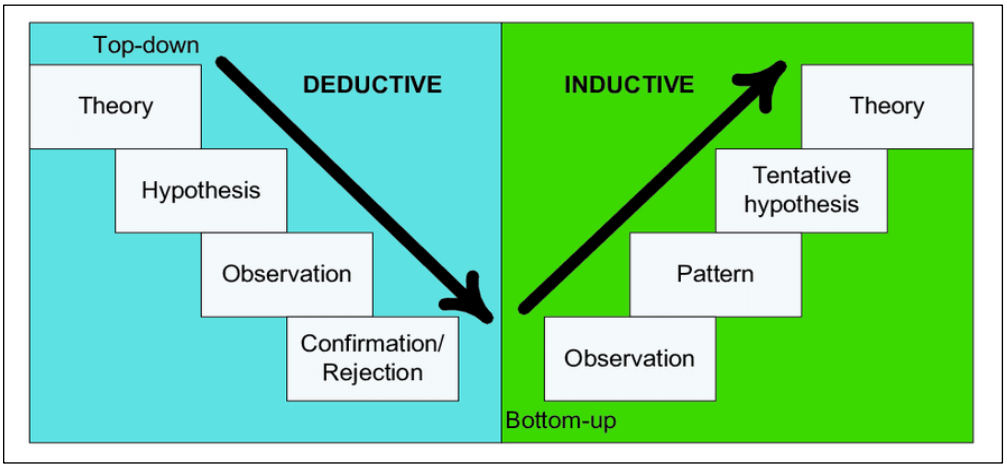


**Figure 3.2: Inductive and deductive reasoning (Burney & Saleem, 2008)**

Lastly, abductive reasoning is developed to complement both inductive and deductive reasoning (Leedy & Ormrod, 2021). Abductive reasoning begins with incomplete data from

different sources and attempts to find patterns and explanations from the available data (Saunders et al., 2019). Therefore, it requires testing of the hypothesis in order to make conclusion.

This study applied the inductive approach. The inductive approach is associated with the qualitative method. The inductive approach is subjective and allows actors to express their experiences in a real setting (Saunders et al., 2019). The inductive method allows patterns to be formulated from gathered data. The outcome from the study based on the inductive approach can also be generalised depending on the settings (Leedy & Ormrod, 2021).

## 2.14 Research method

The most used methods are qualitative and quantitative methods (Barbie, 2021; Leedy & Ormrod, 2021). The other method is known as mixed method, which is the combination of both qualitative and quantitative methods. The IT/IS field uses these methods.

### 2.14.1 Qualitative method

The qualitative method is a systematic method used to seek an in-depth understanding of a social phenomenon in a natural environment (Dawson, 2019). It is exploratory and aims to understand and answer the Why and How questions that describe social interaction (Leedy & Ormrod, 2021). The qualitative method also seeks answers to the problem under investigation, derived from close interaction with the phenomenon (Babbie, 2021). The qualitative method aims to assist in understanding the worldview and how and why things happen the way they do in social reality.

The qualitative method is more of describing and understanding social actors. Data collected through qualitative study represent the feelings, experiences, and emotions of the participants (Creswell & Creswell, 2022). Data is collected in an environment where the researcher interacts directly with the participants within their context using multiple methods such as interviews, observation, and documentation (Leedy & Ormrod, 2021). Using the qualitative method, the researcher can establish patterns and themes during analysis through inductive, bottom-up data analysis (Creswell & Poth, 2017). The qualitative method addresses and interprets the real situation as it emerges and it is subjective (Saunders et al., 2019).

This study followed and applied the qualitative method. This was influenced by the nature of the study that required close interaction with the participants. The interaction is primarily because the researcher needed to understand factors that guide the selection of the most appropriate assistive technology for visually impaired students in practical sessions or classes, to provide guidelines on how to use assistive technology for visually impaired students in

practical sessions or classes and, lastly, to determine how assistive technology can be used by educators to assist visually impaired students in practical sessions or classes.

### 2.14.2 Quantitative method

Quantitative method is defined as a method that collects and analyses numerical data to describe a phenomenon (Babbie, 2021). Quantitative data is collected through surveys and experiments to be quantified. The quantitative method is systematic, and the findings are quantified statistically (Maree & Pieterson, 2025; Xiong, 2022). According to Leedy and Ormrod (2021), the conclusion drawn from quantitative method only makes sense once it is certified through measurement, evidence, and observation.

Ontologically, the quantitative method believes in one reality, and facts are used to confirm this belief (Park et al, 2020). The method depends highly on facts. It is associated with positivism as a stance to explain relationships of variables and measure situational activities (Xiong, 2022). The quantitative method is objective, and the findings are normally generalised to the entire population (Cresswell & Cresswell, 2022). The quantitative method is related to the deductive approach that is based on testing to confirm the findings. Biasness is minimal because statistical numbers and the researcher are not interacting with participants (Babbie, 2021).

### 2.14.3 Mixed method

The mixed method is a combination of both qualitative and quantitative methods that uses rich data to understand complex situations better (Cresswell & Cresswell, 2022). The mixed method provides opportunities to obtain findings that cannot be extracted from using the quantitative or qualitative method. According to Babbie (2021), the mixed method seeks solutions from different perspectives by obtaining rich data. The order of use between the qualitative and quantitative method depends on the research question. Data collection using the mixed methods is preceded by qualitative method for gaining an understanding and testing theory (Bless et al., 2013). The mixed method is challenging and time consuming. Shaanika (2022) indicated that using the mixed method in information systems provides a better understanding of socio technical phenomena.

## 2.15 Research design

Research design is the plan or strategy that the researcher followed to address the research questions to achieve the objectives of the study (Creswell & Creswell, 2022). There are many research designs. Some of the commonly used designs in research include the narrative design, action research, ethnography action, phenomenological research, and grounded theory (Leedy & Ormrod, 2021). The design types are briefly discussed.

### 2.15.1 Narrative research

Narrative research is related to how individuals narrate the life experiences of participants (Barkhuizen & Consoli, 2021). Narrative research is an event-based process, which depends on how well the narrator can go through the event systematically as it happened (Parks, 2023). The researcher follows the story according to how it has been constructed. The stories are based on the environment that participants clearly understand and can relate to their lives (Creswell & Poth, 2017). The narrative design is important because it gives these stories meaning. According to Barkhuizen and Consoli (2021), narratives give participants the opportunity to share their emotions and feelings through story telling. Narrative research is more relevant to studies focusing on history, education, and culture. Narrative research requires extensive data about participants to give it a clear meaning (Parks, 2023).

### 2.15.2 Phenomenological research

Phenomenology is described as the lived experiences of participants or a phenomenon (Creswell & Poth, 2017). The experiences comprise different viewpoints as lived. Phenomenology describes more than explains participants' experiences (Asenahabi, 2019). It captures subjective activities or phenomena that provide a wide range of meaningful experiences. Asenahabi (2019) emphasised that the focus of phenomenology is on a particular group of people to understand and explore their ideas. Phenomenology emphasises the What and How of experiences lived, and the experiences have richer data (Leedy & Ormrod, 2021). The researcher interprets the meaning of experiences. However, the focus is on the description as it happened. Participants should have extensive experience about the phenomenon.

### 2.15.3 Grounded Theory

The grounded theory is more on the interaction with participants in understanding the processes and actions on the ground. The grounded theory requires an interactive process to understand complex phenomenons (Creswell & Poth, 2017). With the grounded theory, data is collected first to develop concepts and theories directly from the available data. Data is collected through multiple stages to complete the process (Dawson, 2019). The grounded theory follows a systematic process to collect and analyse data iteratively to generate patterns and themes (Creswell & Creswell, 2022). The participants and researcher experience the process on the ground to develop a theory. The grounded theory is useful where theories are unavailable or when theories are incomplete.

### 2.15.4 Ethnography

Ethnography is when the researcher studies a group of people interested in patterns relating to language and culture in a natural setting (Creswell & Poth, 2017). Data is collected through interviews and observations. The focus is on the shared patterns of the participants. The researcher is part of the participants during their activities in a real situation for some time. The researcher in ethnography describes and interprets the shared values, language, and beliefs

of the cultural group (Dawson, 2019). The researcher concentrates on the daily life of the participants and asks probing questions as it happens to have a clear understanding.

### 2.15.5 Action research

Action research is an approach that seeks to improve any activity and current practice (Dawson, 2019). Action research focuses on finding solutions to a problem without generalising the outcome. It is a systematic process of identifying a problem, finding a workable solution to the problem, measuring results, if they address the problem, and finally, determining whether the results are satisfactory or not satisfactory (Leedy & Ormrod, 2021). The researcher works closely with the participants to develop a solution. The process is repeated to obtain a workable solution to bring change in the environment (Babbie, 2021). Action research requires the researcher to exercise multiple skills to achieve the objectives of the study. Action research also provides solutions to the problem.

The above research methods were not selected for this study because they are not aligned with the objectives of this study. For example, narrative research is about storytelling, phenomenology is all about the lived experiences of participants and it is subjective, according to how the experiences are interpretated. Grounded theory focuses on creating theories that is related to inductive reasoning. It starts from specific according to available data to general and its process of forming concepts is iterative. Ethnography is the process of seeking understanding about participants in their natural setting on how they interact with one another. Action research is also a reiterative process in addressing a specific problem (Creswell & Creswell, 2022; Leedy & Ormrod, 2021). Whereas this study focused more on the in-depth and understanding a specific situation.

### 2.15.6 Case study approach

Case study approach required a deeper understanding of a particular situation of individual or groups in a real setting. Channaveer and Baikady (2022) define case study as an in-depth exploration of a complex and unique situation or institution in real life context. Case study is applied based on the objective of the study that is descriptive or explorative and the choice of a philosophical stance (Leedy & Ormrod, 2021). Finding from one case study can be generalised to other cases in the similar field of study. The strength of a case study is to permit the use of different method to collect data, which is documentation, interviews, and observations (Yin, 2018).

The Case study approach is divided into three different types, which are exploratory, explanatory, and descriptive (Yin, 2018). Types of case studies can be combined to complement each other, exploratory and descriptive or descriptive and explanatory. Explanatory case study is used to answer the Why question and to gather extensive and in-

depth data of a phenomenon, whereas exploratory is selected where there is unavailability of pre-assumed outcome in understanding a social phenomenon and lastly descriptive case study describe a particular phenomenon (Priya, 2021; Yin, 2018). According to Lavarda and Bellucci (2022) case study approach focuses on the questions such as “who”, “how” or “why” to have a better understanding of activities as they happen in a social reality.

The objectives of this study followed the qualitative method that required a close interaction with participants. Based on the objectives, a case study approach was used as the research design. The IT/IS field normally adopts the case study design because of its focus on in-depth understanding that addresses a particular situation, including human and computer interaction. The study selected two cases from South African higher education institutions. Both institutions are based within the provinces of the country. The following criteria were used to select both cases.

**Criteria for selecting higher education institutions**

i. The higher education institutions must have registered disability students, with the focus on visually impaired students who are totally blind. This confirms that the institutions have the facilities to accommodate blind students.
ii. Both institutions must be willing to participate in the study without any compensation. Both institutions must provide easy access to the selected participants.
iii. Both institutions are higher education institutions. However, the study’s focus area is different. TVET offer certificates and diplomas, while university of technology offers diplomas and degrees. The purpose is to understand the services offered to visually impaired students in the different settings.

### 2.16 Data collection

Data collection is a process of collecting relevant data from different sources to achieve research objectives (Leedy & Ormrod, 2021). According to Babbie (2021), different techniques are available to collect data and the study can adopt any related technique, such as interviews, questionnaires, and observation. The interview and document analysis techniques were used for the data collection in this study.

#### 2.16.1 Interview

The types of interview techniques commonly used in IS/IT research are structured, un-structured and semi-structured interviews. The applicable data collection technique for this study is guided by the research objectives. Data collection is divided into primary and secondary data. Primary data is new and unique data originated from participants that was never published, while secondary data is readily available data related to the study that complement primary data to increase the richness of the data (Babbie, 2021). Secondary data

include any form of documentations that is aligned to the study to answer the research questions. For example, organisational policies. This study adopted the semi-structured interview and document analysis techniques.

- Structured interview

Structured interview is a technique that requires the interviewer to take charge of the interview process. According to Bless et al. (2013), structured interview is a method where all questions are close-ended and there is no deviation from the standard set of questions. The administration of structured interview is easy and quick because participants select answers from the options given. Structured interviews have no influence or exposure to biasness and the method has minimal errors when comparing responses (Taherdoost, 2021). Structured interview is a quantitative method that requires statistical analysis and has the advantage of generalising results to a larger population.

- Unstructured interview

Unstructured interview is almost similar to semi-structured. However, it has no structured questions to allow the interviewer to understand the current situation (Taherdoost, 2021). Some of the questions are formulated during the interview. Unstructured interviews are time-consuming and data analysis is challenging. However, the approach limits biasness.

- Semi-structured interviews

The semi-structured interview technique was selected based on its appropriateness. This technique has characteristics of both structured and unstructured interview techniques (Leedy & Ormrod, 2021). When using the semi-structured interview technique, questions are formulated within the scope of the study, guiding the researcher but not limiting them from pursuing further questioning during the interviews. Interview guidelines are aimed at addressing the objectives of the study (Creswell & Creswell, 2022).

An interview is an informal conversation with the intention of obtaining answers. The conversation allowed new information to emerge through probing with further questions and allowed participants to express their beliefs and experiences (Babbie, 2021). The conversation allowed the researcher to rephrase some of the statements or questions to confirm the same meaning with participants. The researcher continued with the guiding questions once the participant had answered the question with no further probe or any new information coming up. Taherdoost (2021) emphasised that the approach has the flexibility to seek further clarity in case of misunderstanding. The flexibility is through open-ended questions that give participants control to elaborate their answers. The primary reason for this study selecting semi-structured interviews is the openness of discovering new viewpoints to the problem.

### 2.16.2 Criteria for selecting participants

The data was collected from four groups of people: visually impaired students, educators, IT personnel, and disability manager. This is because these are the primary stakeholders in the selection, implementation, and use of the assistive technologies for visually impaired students.

i. Students – participants were selected from students registered in different courses. The criteria used in selecting the participants are as follows: (1) the student must be totally blind; (2) the student must be enrolled in the institution; (3) student must be doing full-time study.
ii. Educator – the educators were mainly those who facilitate classes that include visually impaired students. Thus, the criteria include (1) the educator facilitates a course or subject in which a visually impaired student enrolled; (2) the educator must be using assistive technology; or (3) have used assistive technology in the last six months. This is to ensure that the educator remembers the functions and purpose of the technology.
iii. IT specialist – For the IT specialists, only one criterion was associated with their selection. The IT specialist must have had at least six months experience in the installation, support, and management of the assistive technology. Like the criterion for educators, this was to ensure that the specialists understand the technical functions, including the compatibility of the technology.
iv. Disability coordinator/manager –the manager was selected based on their involvement in the selection and acquisition of assistive technology that supports students.

### 2.16.3 Interview procedure

There is a procedure to be followed when conducting interviews with voluntary participants.

i. Obtained permission

The first step was to seek permission from Mzanzi University of Technology and Orange City TVET participants. Permission was granted based on the research letter of approval from the university which indicated ethical clearance. These include permission letters received from both cases to conduct the study.

ii. Interview guidelines

The following interview guidelines were followed for both institutions to be within the scope of the study.

- Guidelines for students

Which course are you currently studying?

Do you have practical classes and how often?

How do you go about performing your practical work?

Do you have any tools to perform your practicals?

What challenges to you encounter during practicals?

What are the benefits of using the current tool?

What is your experience with this tool?

Do you think the current tool needs any improvement?

Which system do you think will assist you better to perform your practicals?

- Educators

Do you offer courses with practical classes for visually impaired students?

How do you support visually impaired students during practical classes?

What tools do you use to support visually impaired students during practical classes?

Why do you think that tool was selected or preferred?

Do you know of any other tools?

What are some of the benefits of using this tool?

Are the benefits for the students or the lecturers?

Please share with me examples of the benefits

What are some of the challenges that you encounter when teaching practical classes to visually impaired students?

Why do you think those challenges exist?

How are the challenges addressed?

Did you receive prior training to use the system that supports visually impaired students?

- IT technician

How do you provide technical support to technology used by visually impaired students?

What do you think about the technology used in assisting the students?

How was the technology selected?

Why do you think the technology was selected?

What are some of the benefits of the technology? Please give me some examples.

What are some of the challenges of the technology? Please give me some examples.

How were the challenges addressed?

Do you know of any other tools?

What do you think of those technologies?

Why do you think they were not selected in this institution?

- Disability coordinator/managers

The above interview guidelines were also used for the disability manager with only applicable questions.

iii. Pilot interview

A pilot study was conducted as a preliminary interview. According to Leedy and Ormrod (2021) a pilot study is an assessment instrument that assists the researcher to improve certain

processes during the interview. The researcher selected one participant from the list of participants who met the selection criteria to conduct a pilot. Lessons learned from the pilot study assisted the researcher to note highlights from the responses and to formulate follow-up questions which confirmed unclear answers. The researcher received permission from the participant to record the session. This was meant to capture all important data during the interview. The interview was transcribed immediately to remember the reaction while still fresh. The formal in-depth interview followed with all selected participants. Data was transcribed and used for analysis.

iv. Interviews

Pseudo names were allocated to both cases and all participants to adhere to ethics. Mzanzi University of Technology was coded as MUT01 . . . MUTn+1 and Orange City Technical Vocational Education and Training (TVET) participants were OCTVET01 . . . OCTVETn+1. The coding represents the names of the institution and the number of participants.

The researcher introduced herself and the purpose of the study. Participants were assured of confidentiality and anonymity during the interview. A consent form was signed to grant the researcher permission to conduct the interview. There was no remuneration for taking part in the study. The researcher also sought permission to record the sessions and took notes where necessary. It was important for the researcher to thank each participant for being part of the study. After the interview, data was transcribed and coded in preparation for data analysis.

The table below shows the number of participants per institution that were interviewed. For this study, the researcher presented the target group according to the selection criteria. There was no age or gender restriction for all four categories of participants. The requirement for educators and specialists was at least six months working experience with visually impaired students.

**Table 3.1: Number of Participants**

| | | **Mzanzi University of Technology** | **Orange City TVET College** |
|---|---|---|---|
| Category | Educators | 2 | 4 |
| | Students | 5 | 5 |
| | IT technician | 2 | 2 |
| | Disability manager | 1 | 1 |

### 2.16.4 Documentation

Document analysis focused on all available documentation related to both cases (Babbie, 2021). This refers to institutional documentations as mentioned in Chapter 1. The aim of documentation is to complement primary data collected through semi-structured interviews from educators, visually impaired students, and the enablers of the technology (IT specialist) in both cases. Documentation included printed and electronic formats. The researcher evaluated documentation to understand relevant information that impacts this study. For example, historical information that is valuable to the context of the study.

## 2.17 Data analysis

Data analysis is part of the research processes. According to Creswell and Creswell (2022), qualitative data analysis is rigorous and assists the researcher to find meaning towards the study objectives. Data analysis is a process of making sense of the available raw data (Leedy & Ormrod, 2021). Data analysis is to categorise data according to themes used to extract patterns of interest. The study was guided by DOI and CT as a lens. For this study, data was analysed through the guidance of DOI (communication channels) as mentioned in Chapter 2.

The DOI was applied based on the following:

- To identify factors that influence the selection of assistive technology
- To understand how technology is used to facilitate engagement between educators and visually impaired students.
- To understand the guidelines on how technology is introduced to visually impaired students and adopted.
- To understand how the appropriate assistive technology can be used to overcome the challenges of visually impaired students.
- To understand how innovation is diffused throughout the lessons.

CT guided the interpretation of findings

- To understand the identified factors with attributes for strategic change to fit the environment.
- To understand the transition of facilitating lessons to fit visually impaired students.
- To understand structural decision-making that influences performance.

Both theories used components to analyse and interpret data. DOI used components from communication channels, which are knowledge, persuasion, decision, implementation, and confirmation. CT components from the contingency model are environment, strategy, structure, and performance.

## 2.18 Ethical consideration

The study followed the ethics prescribed by the Research Committee of the University (CPUT). Creswell & Creswell (2022) emphasised that researchers should consider ethical issues before collecting data. The two cases where data was collected issued ethical clearance letters before data was collected. Before proceeding with any data collection, all participants were briefed on the objectives of the study. Unethical conduct was not accepted, such as giving participants incentives during data collection. Participants were also informed that they could discontinue with the interview process any time they felt uncomfortable.

Participating in the interviews was voluntary, and the researcher assured all participants that their identities were protected and would always remain anonymous. No names were linked to any data; instead, pseudonyms were used for the institutions and participants with coded numbers. Access to data collected is restricted; only the supervisor and the researcher have access to the data. Data is stored securely with password protection.

## 2.19 Summary

In summary, this chapter presented the research methodology that guided the study. This implies the research method or technique adopted to achieve the research objectives. The qualitative method was selected over other methods due to the nature of the study. The chapter covered the selection of two cases, including how data was collected, analysed, and interpreted using the two theories, DOI and CT. The following chapter discusses the two cases in detail.

# CHAPTER FOUR
# CASE STUDIES OVERVIEW

## 3.1 Introduction

This chapter presents an overview of the higher education institutions in South Africa used as case studies. The two institutions have the same structure but with slight differences in the size of the institutions and the approach to teaching and learning for visually challenged students. The institutions were selected using the set of criteria presented in Chapter 3. The focus of the two institutions is teaching and learning for visually impaired students. The institutions used pseudonyms, Mzanzi University of Technology and Orange City Technical Vocational Education and Training (TVET).

The chapter consists of four main sections. The first two sections present an overview of both institutions. The third section outlines the structure of the institutions and their teaching and learning responsibilities to the students. The last section is the summary.

## 3.2 Overview of higher education institutions

The institutions are a university of technology and a TVET college. Both institutions were established after the merger of higher institutions in South Africa influenced by the transformation of higher education under the democratic government. The merger happened between 2002 and 2005. The transformation was to promote the inclusion of people with disability in higher education.

## 3.3 Mzanzi university of technology

Mzanzi University of Technology was established around 2003 after the merger of institutions previously known as technikons in South Africa. The focus of the merger was to eradicate the differences in higher education and consolidate the focus area into teaching and learning to grow the country's economy. The university of technology is distinguished by its unique career orientation that develops and prepares students for the working environment. Its uniqueness is based on the contribution by the industry for the students to be relevant to the market. The courses require more practical lessons The university is also focused on research output.

The university can host over 40 000 students yearly, which makes it the most established university of technology in Southern Africa. This university has several campuses in different provinces. The academic facility has different faculties, namely, the Arts, Science, Engineering Environment, Information and Communication Technology (ICT), Humanities, Economics and Finance, and lastly, Management Sciences faculties. The qualification varies from higher certificate to doctoral degree with the option of distance learning. The university supports

diversity with the enrolment of staff and students within the country and from neighbouring countries. Some faculties have international and exchange students in certain programmes.

The university offers more than 400 programmes that include online programmes to accommodate different preferences and needs to contribute to building and sustaining the economy. Entry to all these programmes adhere to the education legislation. The enrolment for bachelor's degrees requires a minimum of four subjects with level 4 and diplomas with the same four subjects with level 3. Enrolment is open to all types of students, including students with different disabilities. Such students are accommodated in all campuses, and they need to contact the particular campus of their choice or the disability coordinator before enrolment.

The university embraces the development and use of artificial intelligence (AI) in teaching and research and innovation. These make the university to specialise in some AI spectrums, for example, AI in health and AI in telecommunications. Qualifications offer students the opportunity to fulfill their destinies in the working environment, some as entrepreneurs and international students to make a difference in their own countries. The following section provides the university structure.

### 3.3.1 Institutional structure

The university is purpose-driven under the leadership of an executive management with assistance from substructures to execute teaching and learning. The focus of the university is to create an excellent learning environment for diverse students, including students with special needs. The university has academic and non-academic departments that provide support and development to students living with disabilities.

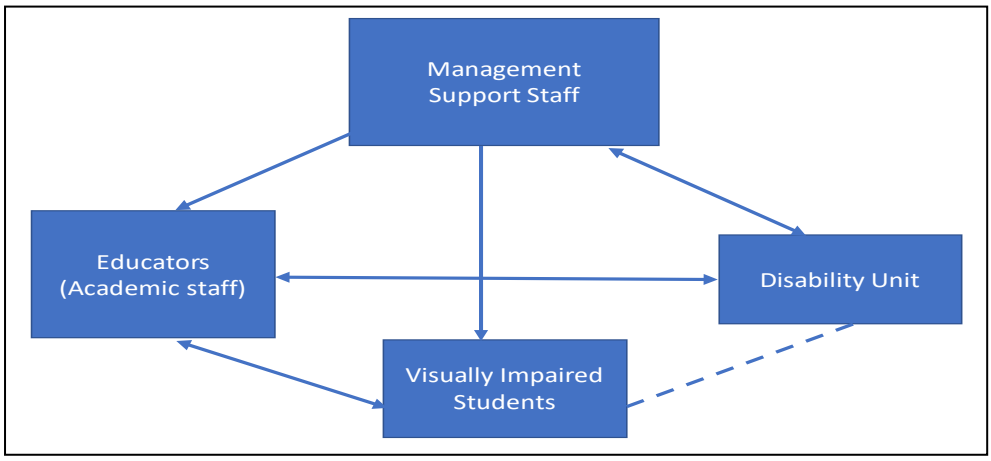


**Figure 4.1: Academic structure**

#### 3.3.1.1 Management and support stuff

The management shapes the administrative role of the university. The management has different portfolios that guide the university's strategic leadership. Management comprises both academic and non-academic personnel, reporting to the vice chancellor, who heads the university. Non-academic staff include the deputy vice chancellor, heads of departments and managers of student support services. academic staff includes executive deans, professors and heads of academic departments.

The management team formulates various policies to support the values of the university, from governance to compliance of student life on campus. These policies are accessible to all. The student support policy is to promote the enrolment of students with disabilities to fit into the university structure. Disability in this context refers to any learning restriction of temporarily or permanently disabled students certified by medical professionals. The focus is mainly on visually impaired students who are totally blind. The policies are designed to improve the infrastructure for the successful inclusion of the disabled students. This also addresses the awareness to eradicate discriminatory attitudes towards visually impaired students in all learning sites.

#### 3.3.1.2 Disability unit

The disability unit is a section supports students with diverse disabilities. The unit ensures that visually impaired students are successfully included in the curriculum with relevant assistive technology. The unit consists of the head of the department, student counsellors, the disability coordinator and an ICT technician. They facilitate different responsibilities as follows:

Head of disability unit

- Formulates and aligns disability policies to the university's strategic agenda.
- Conducts inclusion and accessibility audit for visually impaired students and liaises with external stakeholders.

Student counsellors

- Ensure that visually impaired students are in the safe environment to disclose their different disabilities.
- Evaluate students and conduct assessment processes to determine the students' personal and academic challenges to facilitate necessary support.

Disability coordinator

- Promotes disability awareness and offers training related to the assistive technologies.
- Keeps disability records and maintains confidentiality when communicating with various departments.

- Promotes inclusiveness in the curriculum and arranges training for mobility around the university.

ICT technician

- Maintains the server and uploads new software. Configures and updates computer programs.
- Liaises with service providers regarding new versions of assistive technologies available in the market.

The disability unit is under student support services. Disability students in the university include visually impaired students. The unit provides guidelines and processes for visually impaired students in the learning environment. The unit collaborates with the academics to ensure that learning materials are accessible to all students to promote and sustain the success rate of visually impaired students. The disability unit and faculties advise visually impaired students on the programmes to enroll that will minimize the risk considering the level of impairment. The unit oversees the monitoring and evaluation of the effectiveness of teaching and learning materials of visually impaired students.

#### 3.3.1.3 Educators

An educator is someone who facilitates the teaching of students. The lessons contribute to the career development of the students. The university has different levels of educators from lecturers to professors. The responsibilities of the educators include;

- Develop learning modules with learning outcomes and compile assessment after each lesson.
- An educator should adopt different learning methods to accommodate all types of students, including disability students, to achieve the learning outcomes.

Some lecturers are assigned to teach students with visual impairment in different areas of their studies. Educators work very closely with the disability unit to support the disability students with their special needs. Educators and disability coordinators work closely during the exams to monitor all processes.

#### 3.3.1.4 Visually impaired students

Visually impaired students are students who have no sight. The focus is on the totally blind. These students need some adjustments in their learning activities. The students' learning is significantly different depending on their individual skills. Visually impaired students use assistive technologies to access learning materials at all times. The disability unit is their one-stop service for all the assistance required.

### 3.4 Orange City TVET

Orange City TVET is a technical and vocational education and training college based in Gauteng. The college has a student population of over 20 000 and its main focus is skills development. The college attracts students from communities negatively affected by socio-economic factors which make them to drop out in the middle of the course, especially the disabled students. The college offers assessment to students before enrollment to identity any special needs. The aim is to provide intervention classes to distressed students to eliminate dropouts. The college offers different qualifications; pre-learning programme (PLP), national certificate vocational qualifications (NCV), and national qualification courses (NATED).

The government created NVC to provide students who do not have national certificate the opportunity to complete the certificate. The enrolment requirement for NCV is grade 9. However, PLP also requires grade 9 with English and Mathematics pass. PLP is a bridging programme to NCV. The qualification prepares students for a work-based environment and allows continuation to further studies in the same field through NATED. That makes NCV qualification to be equivalent to national certificate., NATED courses offer both theoretical and practical aspects that also prepare students for the work environment. Students enrol for NATED after completing national certificate. NATED is from N3 to N6, and students obtain the N6 certificate. The combination of N6 certificate and 18 months of integrated learning qualifies a student to achieve the national diploma.

The college offers different programmess in management and business studies, engineering and ICT, and financial management. Within the programmes, the college enrols disability students to comply with the department of higher education and training's inclusion requirement. The college develops policies to support disability students and strategies that will assist in achieving their qualification.

#### 3.4.1 Institutional structure

The management includes the external council, and the principal is responsible for building the managerial team that executes the college's educational mandate to achieve good performance from different students. The interest of the managerial structure is teaching and learning outcomes to empower students for the working environment. The collaboration between the college management, college council, and college board aims to achieve strategic goals and managerial decision-making that benefit the college.

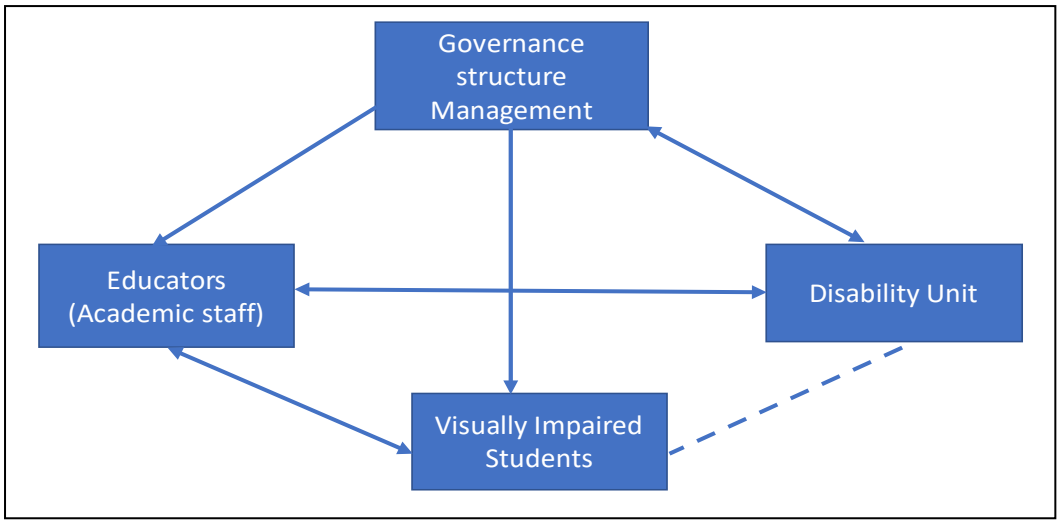


**Figure 4.2: Academic structure**

#### 3.4.1.1 Governance structure

The management of the college is responsible for the successful implementation of the governance framework and systems structure. The structure has non-academics and academics that support the students. The executive management is the principal with unit managers and campus managers. The academic staff is represented by the head of academic programmes, lecturers and student scribes. The non-academic staff comprises the occupational and artisan manager, and the student support manager responsible for the disability unit.

The management has the responsibility of ensuring that the college provides relevant curriculum without any discrimination. It maintains partnership with industry to provide accurate placement aligned with the students' qualifications, including disability students as well as visually impaired students enrolled for both NCV and NATED programmes.

#### 3.4.1.2 Disability unit

The disability unit is a unit within the institution that offers various services to disability students. The students are required to register with the unit to assist the institution in identifying and providing relevant support, according to their needs. The responsibilities of support staff in the unit are as follows;

Departmental head

- Compile policies and provide guidelines for different campuses on inclusion and how to support disability students.
- Capacitate educators to support students during their learning processes and eliminate any barriers.

- Decide the procurement of assistive devices and software and liaise with external sponsors.

Disability coordinator

- Assist disability students to access learning materials without limitataion.
- Organise orientation for disability students to familiarise themselves with mobility around the campus and what is expected from them as students.
- Offer councelling support to the disability students who are unable to manage with the academic pressure or personal circumstances.

Scribes

- Scribe or read learning materials, including examination papers to disability students.
- Assist disabled students with intervention or remedial classes on a one-on-one basis during their free time.

ICT technician

- Liaise with service providers after the procurement of any assistive technolgy that requires installation and configurations.

The disabilty unit works very closely with the Department of Higher Education and Training (DHET) to guide the administration of disability students within the institution. The decision relating to any acquisition of assitive technlogies and the allocation of individual devices for personal use depends on the DHET. The allocation of extra hours during examinations is also approved by the DHET. The unit also manages the exit route for disability students by integrating into the work intergated learning (WIL) program.

#### 3.4.1.3 Educators

Educators are academic specialists who teach all types of students in higher learning institutions. Students need education because it an essential service. The educators at the TVET start from senior lecturers to lecturers and their responsibility is as follows.

- Develop assessment plans for the students.
- Evaluate and monitor students' performance.
- Work together with other educators to improve teaching methods.

Educators support each other on skills and programme development to support the students.

#### 3.4.1.4 Visually impaired students

Visually impaired students refer to individuals with visual impairment, from low vision to total blindness. Visually impaired students also have the right to access higher education. However, accessing learning materials is limited, including interaction with educators during lessons.

This results in prolonging their academic term. These students depend on assistive technology to accomplish their learning objectives.

### 3.5 Summary

The chapter focused on the two selected cases, Mzanzi University of Technology and Orange City TVET. The structure of both institutions was discussed alongside the different responsibilities. The discussion covered the relationship between the different departments. The data collected from both institutions were analysed using the socio-technical theory, which is diffusion of innovation. The data analysis is presented in chapters 5 and 6.

# CHAPTER FIVE
# DATA ANALYSIS CASE #1

## 4.1 Introduction

This chapter presents the data analysis in two parts; case #1 is presented in Chapter 5 and case #2 in Chapter 6, respectively. As discussed in Chapter 1 and revisited in Chapter 3, qualitative data were collected from two cases (#case 1 and #case 2). The data analysis for both cases was guided by the use of diffusion of innovation (DOI) theory as a lens. The DOI is covered in Chapter 2. The cases used in the study were discussed in Chapter 4. The data gathering and analysis were based on the study's aim of to develop an assistive technology framework to aid visually impaired students in higher education institutions in South Africa to learn in practical sessions or classes

The chapter is organised into five main sections. The first section is the introduction, and the second presents an overview of the data analysis from the perspective of two cases. The third and fourth sections cover the data analysis and findings for case 1. The last section summarises the chapter.

## 4.2 Overview of data analysis

Based on the research objectives as stated in Chapter 1, two organisations were used for this study, and they are Mzanzi University of Technology and Orange City TVET College. These two institutions were selected using a set of criteria. One of the institutions is a university of technology and the other is a technical and vocational education and training (TVET) college. Pseudo-names were assigned to the institutions to avoid identity disclosure. Also, the participants in the institutions were assigned code names. This was to comply with the code of ethics, including the South African Protection of Personal Information (POPI) Act of 2013.

This chapter on data analysis focuses on the Orange City TVET College (OCTVET). The coding for the participants were as follows: OCTVET01 to OCTVET14. The DOI theory is employed as a lens to guide the data analysis. There were four categories of participants (visually impaired students, managers, educators, and IT specialist). For each participant, the interview document was transcribed and documented to ensure that formatting is applied to provide lines and page numbers. For example: OCTVETS1, 02:1-2; S represents student 1 of Orange City TVET College, page 2 of the document, and lines 1-2. M represent managers; E represents educators, and T represents IT specialist.

The data was analysed using the diffusion of innovation (DOI) theory as a lens. The theory focuses on how technology is diffused through the environment to achieve the objectives. Thus, DOI helps to gain a deeper understanding of how assistive technology is selected and

diffused to enable and support visually impaired students independently. The communication channel of DOI was employed in the analysis. Roger (2003) describes communication channels as a distribution of messages or innovation from one person to another. As shown in Figure 5.1, five stages, referred to as the 'innovation-decision process', are involved in the communication channel: knowledge, persuasion, decision, implementation, and confirmation.

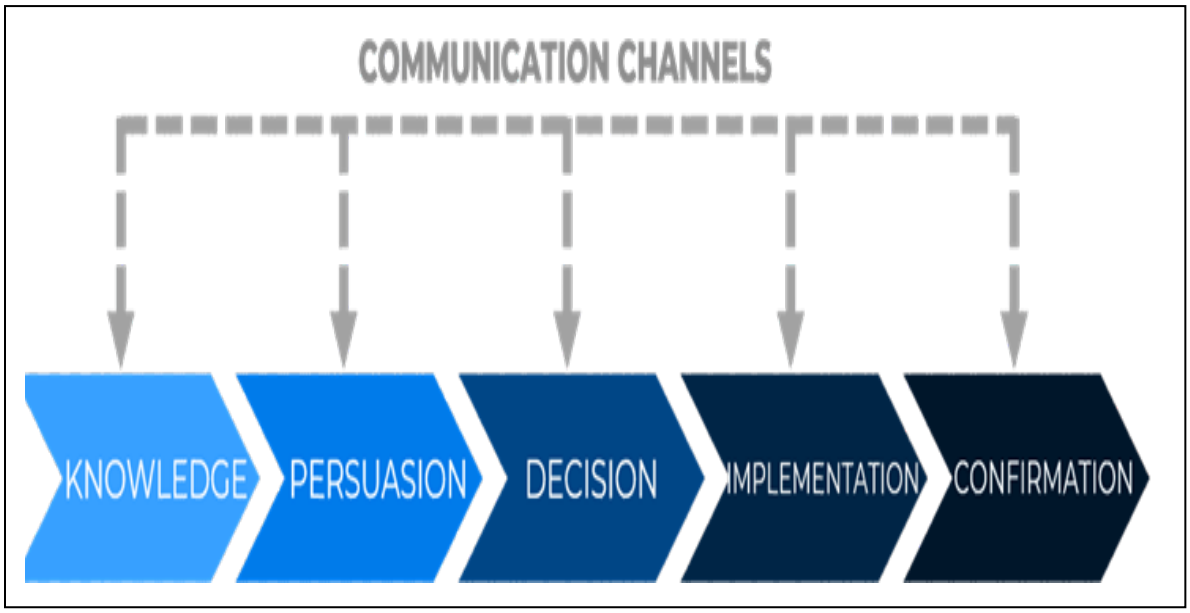


**Figure 5.1: Innovation-decision process**

### 4.3 Data Analysis Case #1: Orange City Technical and Vocational Education and Training College

Orange City Technical and Vocational Education and Training College (OCTVET) is one of the TVET colleges in the country (South Africa). As a case, a comprehensive overview of the institution is presented in Chapter 4. The rationale for selecting the institution is discussed in Chapter 3.

#### 4.3.1 Innovation-Decision Process: Knowledge

Knowledge is the first stage in innovation-decision process. Knowledge about an innovation such as an IT solution (assistive technology) is acquired by individuals and groups from various sources and applied in diverse ways (Iyamu, 2024). Many factors influence the sources of knowledge and the application. Many students gain knowledge about assistive technologies over the years because it is essential for them to do so. The students are inspired to do so for various reasons, such as the cost and ease of use. Some of the technologies can be prohibitive during teaching and learning. For example, high-tech assistive technology such as artificial intelligence eyeglasses. Also, the sophistication of a technology does not determine or guarantee its ease of use. Two of the participants briefly explained the essential use of the technology as follows: "No one has tested this gadget if students can use them and if the

gadget can work in my class" (OCTVETE3,04-05:142-143). "Management hand out gadgets to visually impaired students without training them" (OCTVETE2,06:207-208).

From the educators' perspectives, the factors include interest and technological know-how. Circumstantially, some educators do not see the need to learn how to apply assistive technology since they are not visually impaired. Thus, such educators miss the opportunity know about the available assistive technologies. Also, some of the educators who are interested struggle with technical know-how in assisting the students using the prescribed assistive technology. This could be attributed to a lack of training. Often, the educators are not trained, from which they would have gained knowledge. Primarily, this is because the emphasis is always on the students who are visually impaired rather than the educators. One participant explained: "I think we all share the same sentiments because as I have mentioned earlier, we did not receive any training" (OCTVETE1,03:95-93).

Similarly, selecting and applying assistive technology for visually impaired students is prompted by some factors. Knowledge plays a critical role in selecting and using assistive technology. A lack of knowledge leads to selecting inappropriate assistive technology for visually impaired students. A case in point is that, at the time of this study, the assistive technology used in the institution was not fulfilling the students' needs during their practical studies. According to two of the educators who participated in this study, "This is what we have highlighted; even in Microsoft Excel, there are certain things that blind students cannot do" (OCTVETE2,05:165-166). "This technology is more advanced, but it has limitations. If a student is doing computer practice, JAWS does not read some of the programs" (OCTVETT2,01:29-31).

The need for the acquisition of knowledge about assistive technology is increasingly important. This is attributed to the rapidly growing number of assistive technologies (products or devices). Thus, two types of knowledge are required to cater for both non-technical and technical requirements. The selection and use of the technology depend on and are guided by non-technical and technical requirements. The non-technical factor enables an understanding of the level of the technology's capability and how to employ it to assist the visually impaired in performing their daily functions. From the technical front, the technologies must be understood to enable ease of use, support, and maintenance by visually impaired and IT technicians. These assistive technologies are designed differently with certain complexity in usage and there is a need to have easy access.

Also, based on knowledge, visually impaired students can use the technologies in fulfilling their needs with limited complexities. This includes ease of accessibility, whereby visually impaired

students form part of inclusive learning using the appropriate assistive technology. Inclusion encompasses participation in academic activities, whereby there is no restriction of specific courses for visually impaired students. According to one participant, “I have background and knowledge of computers, and it is better compared to someone starting the computer at the later stage of their blindness” (OCTVETS5,01:14-15). The knowledge also eliminates the attitude towards the use of technology and behaviour towards assisting visually impaired students. The overall knowledge will result in selecting the relevant assistive technology for the right purpose, especially in the practical classes.

Additionally, educators’ knowledge of assistive technology is vital. This is to enhance engagement and fortify interaction with the visually impaired students, in providing teaching and learning services. Thus, educators are expected to develop the skills to facilitate or teach the visually impaired. However, some educators struggle to develop such skills, which affects their support for students and makes learning less effective. Another perspective is that some educators have limited knowledge of assistive technology due to insufficient support from management. Consequently, this restrains them from teaching diverse groups of students. The knowledge of assistive devices bridges the gap between sighted and visually impaired students and increases educators’ efficiency and effectiveness. According to one of the educators who participated in this study: “I am here to teach and assist the students and if management who supposed to support the students and educators but decide to ignore the situation what must we do” (OCTVETE2,06:189-191).

Assistive technologies are increasing rapidly and there exist different levels of understanding of the technologies, from both non-technical and technical perspectives. Based on this, it is in the interest of all stakeholders to develop a standard set of criteria for selecting the most appropriate assistive technology. In bridging the levels of understanding, the set of criteria, including the requirements for developing the criteria should be stored in an accessible repository. For example, step-by-step guides on how to use assistive technology for the visually impaired should be documented and stored in a repository to aid future development and compliance, including decision-making regarding software upgrades. A repository is where knowledge is deposited and stored for future purposes. However, at the time of this study, the institutions did not have any repository.

### 4.3.2 Innovation-Decision Process: Persuasion

Persuasion happens when a person has the power to influence other members of a social system. The power to influence can be drawn from sources such as materials and knowledge, which can be attributable to innovation. Primarily, using assistive technology, persuasion happens from three perspectives, the institution (organisation), visually impaired students, and

educators. However, not all educators, visually impaired students, and management have the knowledge about assistive technology.

Management, on behalf of the institution, was persuaded to adopt certain types of assistive technology. This is attributable to the current policy, which compels higher education institutions to register visually impaired students. Based on the inclusivity policy, the institutions are persuaded to adopt assistive technology that they did not prepare for or understand. This means that the institution does not always necessarily have specific business or technical requirements and the skill to select the most appropriate assistive technology. The implication is that the adopted technology is not necessarily the best 'fit' for the visually impaired students and the environment. Thus, there is a challenge in selecting and adopting assistive technology for visually impaired students' classroom use. Two of the participants briefly explained their views: "The college started to know JAWS with our group. When we first applied to the college, it did not know anything about JAWS" (OCTVETS1,05:163-164). "Then the blind students requested management to purchase JAWS license for the college and do away with the student version that lasts for 40 minutes" (OCTVETT2,02:47-48).

The institution depends on visually impaired students who have more knowledge about IT solutions (assistive technology) to assist in using assistive technology to enhance teaching and learning. Based on the importance of the assistive technology, an awareness tactic was employed to persuade management on behalf of the institution. This was done by inviting service providers to demonstrate the use and benefits of assistive technology. According to one participant: "I have attended an exhibition where service providers demonstrated different assistive technologies that can assist blind people" (OCTVETS2,06:209-2010).

The visually impaired students are persuaded to adopt and use a certain type of assistive technology. The students are persuaded by the institution, their parents (or guardians) and themselves. From the IT perspective, the institution has standards for all its technological solutions. This is to maintain uniformity and ease technical support. Parents of many of the visually impaired are financially constrained. As a result, they comply with what is available, as opposed to appropriateness. Many of the visually impaired students sometimes feel helpless and have no option. Consequently, the students use that as a yardstick to persuade themselves to adopt and use the available assistive technology. However, visually impaired students learn and adapt to the usage of available assistive technology through the assistance and support received from peers. Visually impaired students use the demo version of assistive technology to learn and persuade themselves to contribute to the selection of the technology. During this study, visually impaired students were using assistive technology and acknowledged the usefulness of the technology in their academic work. One of the participants

explained: “Explanation from a blind person to a blind person makes computer easy because the explanation is from real experiences” (OCTVETS5,02:39-40).

The educators find it challenging to use assistive technology to facilitate lectures because they were never exposed to teaching visually impaired students. Management only informed them about the availability of visually impaired students and the use of assistive technology. One participant explained: “Management just told us there is an assistive technology (JAWS) that it is been installed on the computers, and we need to use it to assist blind students” (OCTVETE2,02:62-63). The educators were not persuaded, which makes it difficult for some educators. However, daily interaction between educators and visually impaired students made it easier to persuade educators about the importance of using assistive technology to support them. One participant said: “Lecturers started to be interested in how to teach blind students and I have shared the keystrokes with them for all the levels” (OCTVETS4,01:32-33).

Based on the interest, some educators began researching how best to assist visually impaired students during their practical subjects. According to two participants: “I had to go through it myself and understand what the system was all about and what it does” (OCTVETE2,02:63-64). “I did my research on how to assist the blind students with the support from the students themselves” (OCTVETE3,01:11-12). The assistive technology that is used by both educators and visually impaired students’ needs support from IT technologists to ensure a smooth operation and to prevent any challenges during teaching and learning.

The persuasion of stakeholders to select the most appropriate assistive technology was based on various factors. To the management, awareness was critical, which seemed to be lacking in the institution. The educators require knowledge and skills to understand how various assistive technologies work and how they can be used to facilitate lectures. Visually impaired students preferred the user-friendliness of the technologies. Thus, interactions among the stakeholders were critical for leveraging knowledge and synchronising requirements, from both technical and non-technical perspectives. This is to enable a more informed decision in selecting the most appropriate assistive technology.

### 4.3.3 Decision Process: Decision

Decision is the third component of the innovation-decision process in DOI. At this stage of the process, a decision is made. Rogers (2003) refers to decision as the “full use of an innovation as the best course of action available,” In OCTVET, the decision to select an assistive technology for the visually impaired students was made by the stakeholders, which include the users (visually impaired students), educators, IT specialists, and management (policymakers), to accept or reject the technology solution. The decision of each group (stakeholders) was informed by various factors such as strategic intent, operational capability (user friendliness

and functionalities), and financial implications. In OCTVET, the decision about the assistive technology had negative and positive implications for the stakeholders.

Strategic intent and financial implications were primarily the focus of the management team. The users (visually impaired students, educators, and the IT specialists) were more concerned about the technology's operational capability. From a strategic intent viewpoint, the decision focuses on the appropriateness of the assistive technology solution, from technical and business perspectives. The business perspective refers to return on investment (ROI). By implication, this means that the visually impaired was not prioritised. The users were less concerned about the sophistication of the assistive technology solution. The visually impaired students and educators wanted an ease-of-use solution, while the IT specialists focused on a solution that is compatible with the existing IT solutions (hardware such as server and software) and ease to provide technical support.

Based on the conflicting focuses by both management and users, a definite decision could not be reached. As a result, visually impaired students had limited access to assistive technology. Consequently, visually impaired students struggled because of the unavailability of the assistive technology. Many of the students depended on the online versions, which were free to access. Some visually impaired students could only access JAWS, which is a demo version of the assistive technology. The online versions of assistive technology had their challenges. Some of the challenges include a lack of training and support. The educators did not have the resources to learn or be trained for the online version. The IT specialists also needed training to support the educators and visually impaired students. One participant in the study explained: "When I started, there were only a few computers with JAWS but only running on a 40-minute mode. Then we advised the management to buy the licensed one" (OCTVETS2,03:96-98).

The institution was comfortable with the usage of assistive technology. However, budget constraint and final decision to acquire assistive technology made the process difficult. The delayed financial decision made an impact on visually impaired students' progress as they depended on the assistive technology to normalise their studies. One of the participants explained: "Management is delaying our progress because without the gadget we have limited access" (OCTVETS5,03:75-77). Based on pressure, the decision concerning the financial implications were revisited and addressed, and a licence was obtained for an assistive technology. This eased the challenging burden on visually impaired students and lecturers (educators). One of the participants explained: "The only thing I know, JAWS was a trial operating for 40 minutes and after a long request then late last year that is when management

announced that the head office have decided to buy the license for ten computers and we welcomed the decision" (OCTVETE3,03:85-87).

The revisited management decision to obtain a licence for an assistive technology solution yielded positive benefits. For example, many visually impaired students did not have to depend on human assistance in learning. Also, the decision relating to financial implications helped to appoint student tutors to provide support during practical classes. This was instrumental because some computers' functions were favourable only for sighted students. Institutional policy was guided by the comprehensive compliance to include visually impaired students in the institution. The successful usage of assistive technology and the assistance from student tutors have given visually impaired students the opportunity to perform better, which increased the through-put in practical subjects. Consequently, educators facilitated lectures with flexibility because student tutors were available to assist the visually impaired students.

The assistance from tutors eliminated the pressure from the educators when facilitating the lesson. Despite the decision-based efforts, visually impaired students still faced challenges and continued to depend on humans during practical subjects and projects. This means that the most appropriate assistive technology was not selected. This is attributed to a lack of requirements to select the solution. The lack of the most appropriate assistive technology provides visually impaired students' the justification for not attending lectures. This results in increased failure and dropout rates. One participant explained. "I did perform well in some subjects but not in practical subjects. Based on my poor performance, I did not continue to register for the practice subjects, because it was a struggle" (OCTVES1,01:12-14).

Despite the strategic and financial decisions made by management in selecting and procuring assistive technologies for visually impaired students, educators were not capacitated to facilitate teaching and learning using the solution. This means that there was an oversight decision not to capacitate the educators. This compromised how the educators taught and transferred their skills to the visually impaired students. If there were a set requirement, it would have factored in training for the stakeholders, including the educators. Educators concentrated on trial and error in supporting visually impaired students without any guidance or formal structure. One of the educators who participated in the study: "There is no communication that we receive or any guidelines on how to teach these students, and we have complained about it because we are not trained as educators to teach blind students" (OCTVETE1,01:6-8).

Student tutors who assisted visually impaired students also encountered challenges because of the lack of proper training, as it was their first interaction with the students. One participant explained: "The most challenging thing was that I was not used to working with blind students,

but gradually I have learned and now we understand each other to achieve the same goal" (OCTVETSB1,01:6-7).

### 4.3.4 Innovation-Decision Process: Implementation

Implementation is the fourth stage of the innovation-decision process. It is a stage where decisions about innovation are implemented, which could be to discontinue, reject, continue, or adopt an innovation (Rogers, 1995). Rogers (2003) described the implementation stage as "innovation put into practice." At the institution, OCTVET, JAWS was the preferred assistive technology solution. In putting the innovation (JAWS) into practice, the implementation of the assistive technology was put into action twice.

Firstly, the trial version of the innovation was implemented. A trial version refers to a software (or technology) that has limited access, function, and timeframe. This means that the version is free and not licensed. The version elapses after 40 minutes, which causes abrupt interruption to visually impaired students' learning and educators' teaching. Various actors (stakeholders) such as the visually impaired students, IT specialists, and educators were involved in the implementation of the trial of JAWS. A collaborative effort was necessary to ensure inclusivity and uniformity of the requirements. The implementation was led by the management team, as dictated by the policy of the institution, to ensure the inclusion of the visually impaired in academic activities. The policy does not provide governance or details on how the policy should be implemented. Thus, the management used their discretion and was guided by the policy rather than a set of requirements.

Consequently, the primary users and key stakeholders (visually impaired students) were unhappy with the implementation of an innovation (JAWS' version) that has limited access. Also, fewer educators used the innovation because the limitations of the functions and time did not allow them to be conversant with the technology. Additionally, the IT specialists struggled to provide support for the solution. These limitations had negative implications for both visually impaired students and the educators, from learning and teaching perspectives. One participant echoed the sentiment of other affected stakeholders by explaining: "The 40-minute mode is a challenge, it really disturbs the students because when the students are doing their assessment that takes more than an hour, then in 40 minutes the computer will shut down, and students are forced to restart the computers. This made the students complaint a lot about this disruption" (OCTVETT2,01:12-15)." I was frustrated to resolve the demo queries. I could not even help the frustrated blind students to access their study material because you cannot download any material on the demo version." (OCTVETT1,02:67-69).

When the management realised the unhappiness and discontent among the stakeholders, another implementation process of the same innovation (JAWS) was embarked upon. The

second implementation was to implement the licensed version of JAWS rather than the free version. The licence version permits access to the visually impaired with no restriction. The management decided to implement the solution by acquiring the technology (JAWS). Management facilitated the requisition process through the assistance of IT technicians, thereby enacting inclusivity. The IT technicians, based on expertise, had the power to recommend or reject software for installation within the computer laboratory. Therefore, based on technical requirements, an IT technician led the project by liaising with the service provider.

The lack of governance and requirements in selecting the assistive technology had many consequences, such as inappropriate implementation, limited knowledge, and inconsequentiality, from the educators' and IT specialists' perspectives. This caused more pain and unhappiness for the visually impaired students. For example, the governance defines the processes within which the requirements for the most appropriate assistive technology are gathered. A collaborative effort could have helped to bridge the gap between the stakeholders in leveraging requirements and processes that influence the selection and implementation of the assistive technology in OCTVET.

Many educators had limited knowledge of the assistive technology solution, perhaps because they were not trained on how to apply the technology. This contributed to the challenges and difficulties experienced in implementing the solution, as some educators became hesitant and reluctant to participate in the implementation process. The implication of educators not being involved in the technology disadvantaged the visually impaired, especially when facilitating the practical lessons. Facilitating the teaching of visually impaired students was compromised because of the lack of support from educators who had never used the technology before, which made it difficult for all. One of the educators affirmed: "No, there was no formal training regarding the system or how to teach blind students. We just teach and are not sure if the blind students follow" (OCTVETE4,02:46-47).

Inconsequentiality means no obligatory passage point (OPP). In actor-network theory (ANT), Iyamu (2024) refers to OPP as a mandatory approach, which enacts discipline and coerces actors within a network into adopting the same position and channel in an activity set out by the focal actor or network builder. In implementing JAWS in OCTVET, many of the educators felt that they had no obligation to employ the solution and assist the students in their academic work. This necessitates a governance approach. For educators, no governance or policy compelled them to use or how to apply the assistive technology.

The lack of governance and obligation reduced the control of implementation activities. This inflicted more challenges and pain on the visually impaired students because guidance and

support were limited. As a result, some visually impaired students' academic performances began to deteriorate. Although the management revisited the implementation of the technology to mitigate the situation, damage to academic performance had already been done. This, therefore, calls for awareness in the event and process of selecting and implementing assistive technology in the future, within OCTVET. One participant in the study stated: "You feel so discouraged because lecturers do not understand and how to use JAWS. It is not easy, and along the way you feel like dropping out because there is no support." (OCTVETS3,06:214-215).

### 4.3.5 Innovation-Decision Process: Confirmation

The last stage in the innovation-decision process is confirmation, as presented by Rogers (1995). It means a point of closure after implementing the decision relating to an innovation. The confirmation stage entails a process that includes relevant stakeholders. In OCTVET, as stated above, there were various stakeholders, from students to IT specialists. The stakeholders were consulted and participated in the process of confirmation. This includes the visually impaired students, educators, IT technologists, and management (decision makers).

Although each group of stakeholders had distinctive roles and responsibilities in the confirmation of the assistive technology's (JAWS) implementation in the institution, it was a collective agreement. For example, the role of the management was to finalise and confirm the strategic intent and operational endorsement of JAWS within OCTVET. The management team confirmed the trial version and subsequently, the full version of JAWS. IT specialists were involved to advise management on the technical aspect and confirm the installation in the IT laboratory. These included discussing the specification of computers needed to host the software for the licensed version, loading all learning materials for the students, and confirming that all systems were running. One participant explained: "That is when I was given the permission and go ahead to communicate with the service provider" (OCTVET1,03:72-73).

Visually impaired students confirmed the effectiveness of the system while using it without any challenges. The educators confirmed that putting the assistive technology in place for the students made lessons present effortlessly. This also confirmed that the visually impaired were receiving support. One educator explained: "After having JAWS, it was easy to use it for the practical sessions, the students can now type for themselves" (OCTVE4,01:28-29).

The confirmation was based on the first and second implementation phases. The first confirmation of the technology (JAWS) was the online version that was used by visually impaired students. There were no financial obligations in using the system; however, the only restriction was the 40-minute access. The only setback with the online version was access restriction. IT technologists continued to provide support in the usage of the online version and

confirmed its functionality has challenges. One technician who participated in the study explained: “I had to start pushing and made submission to obtain JAWS license because I have been resolving demo issues that is been recurring without a permanent solution” (OCTVET1,02:71-72).

Even though the online version was functional, there was a need for management to intervene with the strategic decision to have permanent access. Discussions took place for the licensed version and the outcome depended on the decision from the central office because of the structural power dynamic. All financial approvals were done through the central office. One participant affirmed: “The central office is the one that always actions the strategic decision that affects the needs of the students and the college” (OCTVEM1,03:75-76).

The IT specialist technologist confirmed that the visually impaired students had no access restriction after the licensed version was obtained. The movement was the solution (JAWS) officially used by the visually impaired students without difficulties to enhance teaching and learning. The usage by the students confirmed that the technology was successfully installed, and other stakeholders were in support. One participant explained: “I have installed it with the assistance of the supplier. JAWS was running in all computers, and I have not received any challenges after the installation” (OCTVET1,01:8-9). The last stage of the innovation-decision process was the confirmation of how the decision to obtain the licensed version was successfully implemented through the collaboration of all stakeholders.

### 4.4 Findings from the data analysis

The analysis of case #1 was underpinned by the diffusion of innovation (DOI) theory as a lens to identify the factors guiding the selection of the most appropriate assistive technology for visually impaired students for practical subjects. A subjective approach was used in the analysis, and the following factors were discovered: Training, Governance, Complexity, Obligatory approach, Requirements, Strategic intent, Operational capability, and Collaboration. These factors are fully discussed in Chapter 7.

### 4.5 Summary

The chapter presented an overview of data analysis for both cases, Mzanzi University of Technology (MUT) and Orange City TVET College (OCTVET). The analysis was guided by the diffusion of innovation (DOI) theory, focusing on case #1, which is OCTVET. The data analysis primarily focused on case #1 to address the study's aim and objectives.

# CHAPTER SIX
# DATA ANALYSIS: CASE #2

## 5.1 Introduction

This chapter presents the data analysis for case 2. The interpretivist approach was used in the analysis. The diffusion of innovation (DOI) theory was applied as a lens to guide the analysis. The data collection and analysis were based on the study's aim to develop an assistive technology framework to aid visually impaired students in higher education institutions in South Africa to learn in practical sessions or classes.

The chapter is structured into five main sections. The first section presents the introduction, and the second and third sections the overview and data analysis of case 2 respectively. The fourth section follows with the findings from the data analysis. The last section presents a summary of the chapter.

## 5.2 Overview of the data analysis

This chapter presents the data for case #2 which is Mzanzi University of Technology (MUT). Based on the criteria discussed in chapter 5, case #2 focused on a university of technology. To avoid identification, pseudo-names were assigned to the institutions and codenames were assigned to the participants. The coding for the participants were as follows: MUT01 to MUT09. For ease of accessing data during the analysis, a format was formulated. An example of the format is: MUTE01,01:1-2. This implies interviewee number 1 of the Mzanzi University of Technology, page 1 of the interview document, and lines 1 to 2. E represents educators; S represents students; M represents managers; SB represents scribers and T represents technologists.

## 5.3 Data analysis Case # 2: Mzanzi University of Technology

Mzanzi University of Technology (MUT) is the second case used in the study, as explained in Chapters 3 and 4. The rationale for selecting MUT is discussed in Chapter 3. A detailed discussion of the institution (MUT) is presented in Chapter 4. Similar to case #1 (OCTVET), the data analysis was guided by the diffusion of innovation (DOI) theory's innovation-decision process. As shown in Figure 5.1, the innovation-decision process consists of five components: knowledge, persuasion, decision, implementation, and confirmation. The analysis focuses on gaining an understanding of the factors that influence the selection of the most appropriate assistive technology for visually impaired students during practical classes.

### 5.3.1 Innovation-Decision Process: Knowledge

As explained in the case #1 section, knowledge is the first stage of the decision-innovation process. According to Iyamu (2024), it is a stage where an individual or group is first exposed to an innovation. This is critical because of associated information about the innovation such

as assistive technology. Knowledge is acquired from different sources and using various methods (Hannon, 2021). In MUT, there were various stakeholders who required knowledge about the assistive technology. This includes visually impaired students, educators, the institution's management team, and IT specialists. Another factor that made the knowledge critical was that there were various assistive technology solutions in the market. Therefore, knowledge of each of them was important. This includes technical and non-technical knowledge about assistive technology.

Technical functions include technological specification or requirements and compatibility. The technical function, specifically, was to ensure fit within the MUT environment and performance of the solution, while compatibility was to ensure seamless integration with existing IT solutions. Non-technical knowledge covers financial implications, which include acquisition, license, and maintenance costs. In MUT, many stakeholders acquired their knowledge about assistive technologies through presentations by different service providers or media platforms and from peers. Also, some service providers (or product owners) organised exhibitions and demonstrations of technologies. The exhibitions or demonstrations from service providers offer stakeholders the opportunity to test the product to gain more knowledge.

Visually impaired students were expected to know about the innovation (assistive technology). This is primarily because of its necessity. However, some students had limited knowledge about various assistive technologies that were available at the time of this study. Accessing high-tech performance was challenging for the visually impaired students because of its affordability and complexity. Despite having the knowledge about the assistive technology, some visually impaired students find it difficult to access and use the assistive technology for learning purposes. One participant explained: "The tools that are meant for the blind are very expensive, and we learn about the advanced high-tech assistive technology when service providers come to demonstrate these products to us" (MUTS5,03:82-84).

Educators impart their knowledge and skills to diverse students. However, educators face challenges in this regard because it is difficult for them to support visually impaired students through teaching and learning with assistive technology. Educators have no exposure to expand their knowledge on how to interact with visually impaired students and assistive technology. This is due to a lack of planning and training from the management team. Educators' ignorance deprived them of broadening their knowledge and understanding about teaching and learning involving visually impaired students through assistive technology. One educator affirmed: "I am not trained to be of help to those blind students. I do not know even how to assist them with JAWS" (MUTE1,02:57-58). One of the students who participated in the study confirmed: "Lecturers do not have any idea about assistive technology"

(MUTS3,03:77). Also, universities have no guidelines that address how lessons should be conducted for visually impaired students.

Consequently, educators chose not to be interested in teaching visually impaired students and continued with their teaching culture. Educators started to separate students during practical classes, where visually impaired students were directed to the disability unit. The disability unit was equipped with the assistive technology needed by visually impaired students. Also, there was support from the disability coordinator, who assisted educators and visually impaired students to gain knowledge about the usage of assistive technology available in the unit. The assumption was that management failed to support visually impaired students and educators since they also lacked knowledge regarding assistive technology. In addition, the circumstances were new to stakeholders, and visually impaired students ended up being neglected. One of the educators who participated in the study explained: “We are not trained to teach such students. I compile class activities, then send them to disability coordinator to convert activities into an accessible format for the visually impaired through the use of available assistive technology” (MUTE1,01:25-27).

However, in the process, some educators developed an interest and started engaging with visually impaired students despite the lack of encouragement and support from management. Educators made their individual efforts to gain knowledge and understand the technology. The know-how about assistive technology promoted inclusive teaching and learning for all. One of the participants affirmed: “I have knowledge about assistive technology, and I will find a slot in the timetable and meet with the visually impaired once a week, separately at the disability unit” (MUTE2,01:26-28). The right knowledge and capability of understanding assistive technology contributed towards engagement with visually impaired students in the university and benefited other stakeholders.

The university adhered to the policy and procedures of inclusion by acquiring assistive technology for visually impaired students; however, there was no strategy to educate stakeholders to know and understand the assistive technology. This was evident in the support and selection of the technology. Unfortunately, the university selected assistive technology that does not meet the needs of the users (visually impaired students and educators). Misinformation caused the selection of inappropriate assistive technology. An IT specialist who participated in the study explained: "The time I knew about assistive technology was when I received the request for installation from the department” (MUTT2,02:41-43).

Thus, it is important for the IT specialists, as part of the stakeholders, to constantly interact with service providers and advise management on technical aspects of assistive technology,

including computer specifications and compatibility. One IT technician explained: “As a technician, we confirm application specifications from the supplier and check compatibility with what the university has, because every company will promote their products. Approach a specific company directly and start negotiations based on the request” (MUTT2,01:31-33).

### 5.3.2 Innovation-Decision Process: Persuasion

Persuasion is the second stage, after knowledge, in the DOI innovation-decision process. Roger (2003) explains that persuasion happens or occurs when an individual has a negative or positive attitude about innovation. At this stage, stakeholders with relevant knowledge play a very critical role in persuading each other to adopt innovation.

In MUT, there were internal and external stakeholders. The external stakeholders were the government (South African higher education), while the internal stakeholders included the management team, visually impaired students, IT technicians (specialists), and educators. South African higher education introduced guidelines for the inclusion of the visually impaired in the system. These guidelines, as stipulated in the policy, persuaded the university to include the visually impaired students and the assistive technology. The management team relied on policy and governance to persuade employees, such as educators, IT specialists, and the visually impaired students, to adhere to standards, rules, and processes for adopting assistive technology.

Stakeholders without knowledge about the assistive technology needed to be persuaded to accommodate them in the adoption. In adopting assistive technology in MUT, stakeholders were persuaded, primarily, from two different angles: end users (visually impaired students) and management. From the end users’ perspective, on the one hand, visually impaired students with high-level experience in using the assistive technology persuaded their fellow students to minimise the complexity of accessing the technology.

On the other hand, visually impaired students had to persuade management and other stakeholders to adopt the technology. This was because the visually impaired students deeply felt the absence of, or inappropriate, assistive technology in continuing with their studies. There were no alternative preferences because the university invested in only one assistive technology (JAWS). As a result, students were confined by the environment and its offerings, meaning the visually impaired students were persuaded and exposed to JAWS. One participant commented: “Blind students use JAWS because it is the only software that is available in the university and students have access through the disability unit” (MUTT1,03:75-76).

Management persuaded stakeholders, including visually impaired students, to adopt the available assistive technology, JAWS. The choice was not based on technicality or requirements but on ease of access. This means it was cheaper to acquire. One of the students who participated in this study claimed: “As a blind student, I have never attended any training regarding how JAWS works. I normally receive assistance from other blind students who know JAWS better. During my spare time, I go to the disability unit and practice” (MUTS2,05:179-181). Management employed the assistive technology (JAWS) without identifying the implications for teaching and learning, and whether the assistive technology was the most appropriate to address users’ needs.

Additionally, the management team persuaded the disability coordinator to engage with visually impaired students to use JAWS. This did not involve any training of stakeholders, such as the end users (visually impaired students), educators, and IT technicians. An information session was used to persuade the stakeholders. At a lower (than the management) level, the disability coordinators persuaded visually impaired students to familiarise themselves with the available assistive technology. In the process, the disability coordinators learned about and developed an interest in JAWS to mitigate challenges experienced by visually impaired students. One participant confirmed: “I did not have training, I trained myself by navigating through the options until I found what I wanted so that I can be able to assist the students” (MUTT1,02:57-59).

The disability unit has fully operational computers with JAWS without procedures that guide visually impaired students and educators on how to utilise the technology. Visually impaired students persuaded themselves individually or as part of a group to visit the disability unit within the prescribed hours. The restriction is part of the university’s operational hours, governed by policy. When visually impaired students experienced difficulties in accessing the disability unit during stipulated hours, they fell behind with their studies. The main reason is that the visually impaired students do not have access to alternative assistive technologies because they are expensive, and some visually impaired students are disadvantaged and cannot afford to purchase their own devices. One of the participants explained: “Disability unit operates within office hours, from 8:00 and 4:00, and we encourage each other to visit the unit to get used to the assistive technology during our spare time. It is unfortunate, because sometimes you need to use the services after hours” (MUTS2,05:181-184).

The educators were informed about the visually impaired in class, but they were not encouraged to be trained and to understand the functionalities of the assistive technology (JAWS). This impacted how integrated learning was conducted, inclusive of the sighted and visually impaired. For example, some educators had a lacklustre approach to their service

delivery (teaching and supporting) to the visually impaired students. Two of the participants explained: “Lecturers as well face the same challenges because there are no JAWS installed in the normal labs, and that is why lecturers show no interest” (MUTS4,03:78-79). “Sometimes you end up not having interest in consulting with the lecturer even when you encounter any challenges because the person already told you that he is not trained to deal with blind students” (MUTS1,01-02:34-36).

As a result, the management team was persuaded by the information received from the service providers to acquire the assistive technology, and the acquisition was done without considering who and how training would be conducted to support stakeholders. Awareness workshops were arranged to persuade visually impaired students, but there was no actual training on the usage or guidelines on how to access the assistive technology. One participant explained: “Disability coordinator made the blind student aware of the services and the type of technology available at the disability unit, but there was no formal training on the usage” (MUTT1,01:23-24).

### 5.3.3 Innovation-Decision Process: Decision

The decision stage follows the persuasion stage in the DOI innovation-decision process approach. As stated in case #1, a decision happens when someone accepts innovation or rejects it (Rogers, 2003). This means that, notwithstanding, a decision must occur during the process of selection, adoption or use of an innovation. In MUT, a decision was made to procure assistive technology. This was to support visually impaired students performing their academic activities. However, various factors from both technical and non-technical viewpoints influenced the decision to procure the current assistive technology in the university.

Decision-making required collaboration amongst stakeholders who are directly impacted when using the assistive technology. These stakeholders consist of management (strategic leaders), visually impaired students, educators, and IT specialists. The management guides the university regarding the decision to or not to procure IT solutions. The visually impaired students are the end users of the technology, which makes them key stakeholders. The educators facilitate lectures using the technology to assist the visually impaired students. IT technicians were responsible for all technical support in the university.

The management team with the strategic mandate took control and implemented the decision to purchase the IT solution (assistive technology) to close the gap that restrained visually impaired students from participating academically, especially in practical lectures. The decision was based on cost rather than requirements, from technical and non-technical perspectives. Also, the management’s decision did not consider inputs from other stakeholders, such as visually impaired students, who understand the capabilities of the assistive technology, and

the IT specialists who provide technical support for the technology, ensuring its compatibility. One of the participants in the study briefly explained: “As technicians, we were not involved in the decision making. The management team is the one that decides about the tool they need for the university to cater for the blind students” (MUTT2,01:20-21).

Visually impaired students continue to experience challenges in their learning space because the assistive technology (JAWS) was imposed on them, and it lacks some functionalities. Also, the IT specialists struggle to provide support for the technology. This made the visually impaired students resist the adoption of the technology by not attending practical classes. Their grievances included the fact that no one advocated for them to be integrated into practical classes. Most visually impaired students considered self-study based on the attitude of other stakeholders. One student who participated in the study confirmed: “I only attended theory classes because during practical classes, I would be bored, doing nothing while other students were performing the practicals, so it was quite difficult” (MUTS2,01:10-12).

The educators were not included in the decision to adopt the assistive technology in the MUT. The educators’ behaviour was also aggravated by a lack of training because the decision to obtain the assistive technology was taken without a proper plan for empowering them. Educators continued with their normal teaching that excluded visually impaired students. As a result, skills transfer was restricted, and visually impaired students felt isolated despite having access to the assistive technology. One educator explained: “Educators have no power to make decisions, even though we are the ones working with the blind students. When you address matters concerning the visually impaired students in the meeting, management does not act on it” (MUTE2,02:38-41).

IT specialists were mandated to provide technical support for new software acquired by the university. IT specialists encountered challenges with the installation of the assistive technology because the management team did not engage them during the acquisition process to understand the requirements needed before installation. The installation took longer than expected because of insufficient information. IT specialists decided to overcome the challenges of installation by reaching out to the service provider for assistance and guidance. These included confirming the compatibility of the computers to be installed with the technology. One participant explained: “We had to research to have more information and also involve the company. The company was willing to assist until we succeeded with the installation. The university labs differ according to the configuration, and some lab configurations had to be changed to comply with the specifications of the software and to make it work” (MUTT2,02:61-65).

The decisions by the stakeholders were challenging and required shifting negotiations. The challenges were compounded by policy, requirements, and standards that guide the selection, adoption, and use of the assistive technology in the institution. Consequently, the assistive technology (JAWS) was not suitable for practical classes where visually impaired students could be independent. Thus, a new assistive technology called Fusion was explored.

### 5.3.4 Innovation-Decision Process: Implementation

The implementation stage is the fourth stage of the DOI innovation-decision process. According to Rogers (2003), an innovation must be put into practice through decision implementation. The implementation stage is also described in case #1. In MUT, the implementation of the innovation (assistive technology) for visually impaired students was executed in two different phases because of the two solutions. The first and second phases were the implementation of JAWS and Fusion, respectively.

The decision to adopt JAWS was implemented to support visually impaired students. The implementation process was led by the management team. The implementation was to ensure that visually impaired students were appropriately supported by using assistive technology. The implementation was intended to improve the inclusion of visually impaired students in the university, to access relevant materials for teaching and learning according to the education policy. The policy did not stipulate how and who would be responsible for guiding the visually impaired students to access and monitor the ease of use.

Although not all stakeholders were involved in the decision to adopt JAWS, the implementation of the technology (JAWS) was made obligatory. The non-inclusive or non-consultative approach to the decision to purchase and adopt JAWS affected the stakeholders one way or the other. As a result, many visually impaired students were not pleased about the implementation of the technology. Some visually impaired students attributed their challenging experiences with JAWS, especially during practical classes, to the non-consultative approach by the management.

One of the implications for the visually impaired students was that they had to train themselves to operate the assistive technology. Some educators did not know the importance of and how to employ JAWS to engage with visually impaired students in teaching and learning. From a support perspective, IT technicians struggled with the installation of the technology, especially the fact that it did not include troubleshooting materials. One participant explained: “The challenge with JAWS does not describe the pictures; when it comes to a picture, it is not talking and to bypass the picture, the lecturer must come to assist” (MUTS3,02:60-61). In the process of using JAWS, there was a technical disruption in the 40-minute mode resulting from the lapsed licensing. This was temporary; however, visually impaired students’ studies were

compromised. One participant explained: “The delay of license renewal caused the instability of JAWS that, after every 40 minutes, it will restart if it is not licensed. The IT specialist needs to upgrade as soon as the license expires” (MUTS2,03:85-87).

Management decided to adopt and implement a different assistive technology (Fusion). However, the implementation of both technology solutions (JAWS and Fusion) did not resolve the challenges visually impaired students were experiencing during practical lectures. Visually impaired students with more advanced knowledge about assistive technologies were not in favour of the implementation of Fusion, as its functionalities were almost similar to JAWS. This was caused by a lack of requirements, which would have guided the selection of the most appropriate solution. One participant in the study explained: “I use both depending on what I am doing, both are not fulfilling, that is why I alternate them” (MUTS5,01:13-14). “Fusion is still new in the market, and it is not well developed because some of the keystrokes are not the same as JAWS” (MUTS5,01:16-17).

Stakeholders were confused about the implementation and usage of Fusion because the installation was completed with no training offered. Visually impaired students continued to utilise JAWS. However, the management expected the innovation (Fusion) to benefit the users. Visually impaired students were informed by disability coordinators about the installation of Fusion. Stakeholders showed perseverance in learning both assistive technologies for their own benefit. The management lacked the proper knowledge to select the appropriate assistive technology for visually impaired students. Thus, it is necessary to create awareness for all stakeholders about assistive technologies to break the barrier to selecting the most appropriate assistive technology for the visually impaired. One participant asserted: “I think I have used Fusion for a month, and I am not really familiar that much with Fusion because it is new and there was no training as yet” (MUTE2,02:68-69).

### 5.3.5 Innovation-Decision Process: Confirmation

In DOI, the confirmation is the last stage to complete the innovation-decision process as explained in case #1. The two innovations that were implemented in MUT to assist visually impaired students were confirmed to be used. According to Rogers (2003), the decision can be reversed if the individual is “exposed to conflicting messages about the innovation.” All stakeholders were involved in the process of confirming the acceptance of both assistive technologies, JAWS and Fusion. The innovation was confirmed by stakeholders as they utilised it for academic purposes. Visually impaired students persevered and participated fully in using the technologies for academic purposes. However, the confirmed assistive technologies were accessible with limitations, though it was sufficient for the students to function effectively in some academic activities.

The first confirmation was JAWS with its limitation to access pictures and Microsoft application partially. Also, expired licences forced visually impaired students to use trial versions that run for 40 minutes. The 40-minute mode was confirmed as a substitute in the interim. One student who participated in the study explained: “The delay of license renewal caused the instability of JAWS that, after every 40 minute it will restart if it is not licensed and really caused delays when busy with assessments” (MUTS2,03:85-87).

The second assistive technology to be confirmed in MUT was Fusion. IT technologists confirmed compliance and compatibility of Fusion with university specifications. The end users found it difficult to access Fusion because the functionality of this technology was complicated and there were no guidelines. These technologies were both confirmed by the university’s stakeholders and service providers. One participant explained: “Fusion is still new and complicated because one cannot use normal keystrokes combination” (MUTS5,01:23-24).

The availability and access to the assistive technologies encouraged stakeholders to agree and confirm the usage. The assistive technologies did not provide ease of use in practical subjects. The confirmation from management did not consider the needs of visually impaired students because the selection was based on a non-technical perspective. There were no criteria in place to select the most appropriate assistive technology for visually impaired students relating to practical subjects.

### 5.4 Findings from the data analysis

The findings from the data analysis of case #2 presented above were influenced by subjective reasoning using diffusion of innovation (DOI) as a lens to achieve the aim and objective of the study. The following findings were presented: Training, Policy, Complexity, Obligatory, Requirements, Levels of stakeholders, and Culture. Both findings from case #1 and case #2 are discussed in detail in Chapter 7.

### 5.5 Summary

The chapter presented the overview of case 2, Mzanzi University of Technology (MUT), which entailed the formatting and coding of how to access the transcribed document. Also, data analysis for case 2 was underpinned by the diffusion of innovation (DOI) theory to address the study’s aim and objective, as illustrated in chapter 5.

# CHAPTER SEVEN
# FINDINGS AND INTERPRETATION

## 6.1 Introduction

Data were collected based on the study's aim and objectives. The methods and techniques applied are discussed in Chapter 3. The data were analysed using the diffusion of innovation (DOI) theory. The data analysis and discussion of the theory are presented in Chapters 2 and 5, respectively. This chapter presents the findings from the data analysis and the interpretation of the findings. The contingency theory (CT), also discussed in Chapter 2, is used as a lens to interpret the findings. The findings were interpreted to achieve the study's aim, of developing a framework to aid visually impaired students in higher education institutions in South Africa to learn in practical sessions or classes.

The chapter is organised into six main sections. The first and second sections provide the introduction and an overview. The third section covers the findings from the data analysis, from the cases (institutions) used in the study. In the fourth section, the findings are interpreted to gain a better understanding of the factors influencing the selection and use of assistive technology for visually impaired students in South African institutions of higher learning. A framework for assistive technology for visually impaired students is presented and discussed in the fifth section. Finally, a summary of the chapter is presented.

## 6.2 Overview of findings and interpretation

The data analysis guided by diffusion of innovation (DOI) is presented in chapters 5 and 6. The data analysis led to the findings from the two cases: Orange City Technical and Vocational Education and Training (OCTVET) and Mzanzi University of Technology (MUT). The findings are the factors revealed to influence the selection and use of assistive technology for learning purposes, from both enabling and constraining perspectives. The findings are tabulated in columns in Table 7.1: Case #1 and Case #2, respectively.

As discussed in chapters 1 and 2, the findings from data analysis (chapters 5 and 6) are interpreted using the contingency model from the contingency theory (CT). The rationale for selecting the CT for this is also discussed in previous chapters (1, 2, and 3). The model consists of four components: structure, environment, strategy, and performance. As shown in Figure 7.1, CT does not dictate the directions of the components – where it starts or ends. In this study, the model is applied from left (structure) to right (performance). A detailed discussion on the components of the theory is presented in chapters 1 and 2. As an overview, a brief explanation of each component is presented.

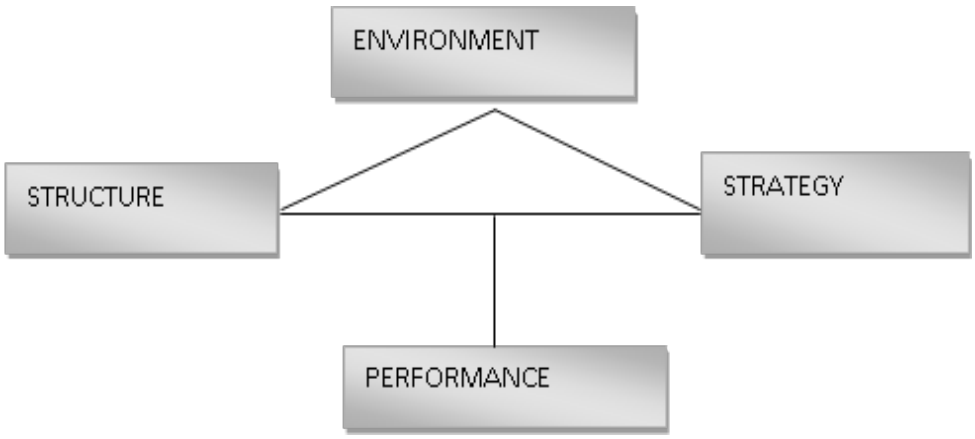


**Figure 7.1: Contingency Model (Blanton et al., 1992)**

Structure focuses on subsystems, which include units, towards achieving organisational objectives. Husted (2000) described how structure illustrates a clear flow of activities and processes within an organisation. The environment allows the organisation to adapt to the current circumstances, which are influenced by the internal and external factors, to enhance stability (Iyamu, 2021). Strategy is the fundamental aspect of any organisation towards sustainability and competitiveness. A good strategy enables performance and allows changes depending on the contingency variables (Donaldson, 2015). Performance is underpinned by the relationship between strategy and structure to improve productivity (Hui, 2024).

### 6.3 Findings from the data analysis

Based on the objectives presented in Chapter 1 and revisited in Chapter 3, two institutions (cases) were used in the study. The findings from the cases are presented in this section. Firstly, the findings could not be separated because they steer towards the same aim and objectives of the study. Secondly, since it is not a comparative study, the comparative approach could not be applied. Thus, the findings from both cases were combined through a mapping process to eradicate duplications. Subjectivism was applied in mapping the findings (factors). Subjectivity is about personal viewpoints or lived experiences to express own understanding, Lundberg et al. (2023) explained.

A two-step approach was employed in the final findings gathered from the two cases. In step one, the findings from Case #1 and Case #2 are tabulated in Table 1.1, in their respective columns. In the second step of the approach, the findings from the two cases were mapped, also shown in Table 7.1, which entails merging similar factors.

**Table 7.1: Findings from data analysis**

| Step One: Findings from the cases | | | | |
|---|---|---|---|---|
| # | OCTVET (Case #1) | | # | MUT (Case #2) |
| 1. | Training | | 1. | Training |
| 2. | Governance | | 2. | Policy |
| 3. | Complexity | | 3. | Complexity |
| 4. | Obligatory approach | | 4. | Obligatory |
| 5. | Requirements | | 5. | Requirements |
| 6. | Strategic intent | | 6. | Culture |
| 7. | Collaborative | | 7. | Levels of stakeholders |
| 8. | Operational capability | | | |
| Step Two: Mapping the findings | | | | |
| 1.Training; 2. Governance; 3. Requirements; 4. Obligatory approach; 5. Complexity; 6. Strategic intent; 7. Operational capability; 8. Collaborative; 9. Culture; and 10 levels of stakeholders | | | | |

To avoid disparity and achieve the objectives of the study, it was critical to map the findings from the two cases. Marx (2022) explains that mapping is important to understand the interconnection or relation of meaning in the data from different areas. Table 7.1 was created using the identified findings. The findings were mapped to build a connection and relationship between the findings from both cases. Mapping also eliminates overlapping factors from the sets of findings.

### 6.4 Interpretation of the findings

The findings from the data analysis are interpreted using the contingency theory (CT). An overview of the theory is presented above, and a comprehensive discussion is provided in Chapter 2. As shown in Figure 7.1, the theory consists of four components (structure, environment, strategy, and performance). The interpretation was to gain a deeper understanding of the factors that guide the selection of assistive technology for visually impaired students in practical sessions or classes. This includes formulating guidelines on how assistive technology can be used by educators and supported by information technology (IT) specialists. The interpretation of the findings (factors) followed two steps.

In the first step, the factors were categorised and associated with the components of CT, as shown in Table 7.2. This was done by applying subjectivism, which allows individual perspectives in inducing meaning into a subject or object (Omodan, 2022). The second step presents the use of CT's four components as a lens to interpret the factors, based on the first step. This means that each CT component focuses on specific factors. For example, structure

focuses on governance and levels of stakeholders; environment is concerned with requirements, complexity, and culture; strategy focus on obligatory approach, and strategic intent; and lastly, performance is related to training, operational capability and collaboration.

**Table 7.2: Findings associated with Contingency Theory Components**

| Step Three: CT components and findings | |
|---|---|
| CT Components | Findings from analysis |
| Structure | Governance |
| | Levels of stakeholders |
| Environment | Requirements |
| | Complexity |
| | Culture |
| Strategy | Obligatory approach |
| | Strategic intent |
| Performance | Training |
| | Operational capability |
| | Collaborative |

### 6.4.1 Structure

The structure in the context of contingency theory allows organisations to share operational activities to achieve organisational outcomes. According to Vaszkun (2024), structure is formed by human elements to explore contingencies in decision-making that guide working processes to enhance performance. Within the institutions (OCTVET and MUT) structure is defined, such as the management team, academics (educators), and the IT unit, which are the levels of stakeholders. Each group (structural unit) of stakeholders has its focus and deliverables, which are managed and controlled through governance. The governance includes principles, policies, and standards (Turner, 2022).

Based on the policies and standards, the roles and responsibilities of each group of stakeholders are defined (Müller et al., 2023). On the one hand, the governance ensures that there are no duplications of deliverables and duties. On the other hand, inclusivity is ensured to avoid domination and discrimination. It is based on governance that the levels of stakeholders, such as the educators and visually impaired students, were not happy that they were not included in the decision to adopt JAWS as an assistive technology in the respective institutions. Based on standards and principles governing IT solutions, the IT unit (or specialists) contributes requirements to the selection and use of assistive technology.

This includes how the technology is implemented and how educators apply the technology to assist students. Thus, structure helps to outline different activities for the level of stakeholders from both technical and non-technical perspectives in the selection of the most appropriate assistive technology. Structure in governance assists in reviewing strengths and reveals weaknesses in the organisation. One of the weaknesses identified in this study is a lack of skills among the levels of stakeholders, as many of them struggled to apply the assistive technology to support visually impaired students.

### 6.4.2 Environment

The environment is where organisational activities take place, such as in academic institutions. In selecting and using assistive technology to support visually impaired students, the focus of each environment (OCTVET and MUT) was influenced by factors such as requirements, understanding of complexity, and the role of culture. The assistive technology must suit the environment primarily because the settings vary, from both strategic and operational perspectives. Thus, the strategic intent and operations of each environment are influenced by requirements, which consist of technical and non-technical factors. The environment needs to consider both requirements to guide the selection of the most appropriate (fit) assistive technology for the visually impaired students.

The technical and non-technical requirements should align with each other within the relevance of the environment (OCTVET and MUT). The alignment of the requirements helps to select the most appropriate assistive technology. For example, the technical requirements entail the specification of how the assistive technology fits within the institutions' environments. This includes compatibility with existing systems, such as software enablement. From a CT perspective, the successful implementation of an IT solution depends on fit (Iyamu, 2024). The non-technical requirements focus on operational activities, which constitute processes and usability of the assistive technology by visually impaired students. This can also include legal and service level agreement (SLA) between the service providers and the institution. The requirements reduce the complexity of the technology application within the environment. This enhances implementation success, which improves a culture of inclusivity, making visually impaired students more comfortable.

In the case of MUT, collaboration between IT specialists and service providers was necessary to eliminate any complexity during the installation and configuration of the assistive technology. Thus, environments have different settings, which assistive technology must fit to enable visually impaired students to perform their academic activities. Some assistive technologies are pitched at a higher level when the technology becomes complex to manage (Kafouros et al., 2025). To overcome technical and non-technical requirements and the complexity around

the selection of the most appropriate assistive technology, institutions need to develop a culture that promotes standardised procedures to formulate requirements and to overcome challenges in the selection of assistive technology. The culture promotes a set of values and behaviours that are transferable (Tadesse Bogale & Debela, 2024), from processes to the implementation stages.

### 6.4.3 Strategy

A strategy gives direction in an organisation on how activities are carried out. This means that the strategy guides environmental activities focusing on the short- and long-term bases (Cory, 2024). Thus, the strategy must be formulated to allow adaptation to changing needs within an environment and enhance competitive advantage. This is important because higher institutions compete for students through the services that they provide. Primarily, this is because strategy governs the functions of the institutions, and it is obligatory to stakeholders. This means that stakeholders must adhere to the rules, roles, and responsibilities that are assigned to them within the structure (Hagoug, 2024). These attributes guide the stakeholders in their participation in the selection and use of the most appropriate (fit) assistive technology. The roles and responsibilities within the structure are intended to promote collaboration and provide support for the use of assistive technology for the visually impaired.

The choice of assistive technology is a strategic intent. The intent can only be implemented by selecting the most appropriate assistive technology for visually impaired students through an obligatory approach. This means that the stakeholders are mandated through a narrow path that forces them to converge on a specific action (Iyamu, 2024). The strategic support and structure eliminate organisational challenges (Dlamini, 2022). Thus, the most appropriate assistive technology is selected among the available assistive technologies in the market to align it with the needs of the stakeholders. Successful implementation of the strategy would assist in prioritising relevant resources towards the acquisition of assistive technology to promote inclusion in higher institutions and strengthen the capabilities of visually impaired students and educators.

### 6.4.4 Performance

Performance depends on many factors, as revealed from the data analysis presented in the previous chapters. One of the factors is changing environment and circumstantial situations. Another influencing factor is an organisation’s attempt to achieve its goals by aligning strategy and structure for competitiveness (Garavan & O’Brien, 2024). These factors are about fit. CT focuses on the fit or unfit where there is no best way for managing an organisation to perform better or successfully (Iyamu, 2021; Miller, 1988). An understanding from the CT perspective induces the need for training, operational capability, and collaboration to ensure fit. Thus, training is needed as an attribute to capacitate stakeholders through enhanced performance

of assistive technology. Also, the training can improve stakeholders' knowledge, develop internal skills, increase awareness, and enhance know-how about assistive technology for visually impaired students. The training should cover areas such as technology enablement, educators' support, and visually impaired students' use of the technology.

Stakeholders (structural unit) in both OCTVET and MUT are unable to execute their mandate in interacting with the assistive technology as a result of a lack of training and strategic intention, which is mandatory for stakeholders who contribute towards the selection of the most appropriate assistive technology. Thus, collaboration with the internal stakeholders (the institution's management, IT specialists, educators, and visually impaired students) and external stakeholders (such as industry experts and the government) is critical. Collaboration amongst stakeholders increases performance where interest in the innovation (assistive technology) will emerge.

The collaboration entails factors such as interaction, relationship, and alignment, to facilitate the fit of the adoption and use of assistive technology within the environment. The structure (managers, educators, IT technologists and visually impaired students) presents different levels in the institutions that have no alignment in supporting each other with the know-how of selecting the most appropriate assistive technology to perform or give support in practical classes. Thus, performance could not be achieved because of insufficient skills to utilise assistive technology from both institutions (OCTVET and MUT).

Based on the limited knowledge of some stakeholders, the selection of the most appropriate assistive technology was challenging. Consequently, there was misalignment between the selected technology and the needs of the visually impaired students, which affected fit. As a result, the academic performances of the visually impaired students were impacted. Iyamu (2021) emphasised that proper fit leads to successful performance. According to Blanton et al. (1992), interaction and relationships encourage the structure to perform.

A good relationship between stakeholders builds a strong foundation and aligns technical and non-technical requirements for better performance. The alignment of roles and responsibilities encourages educators to support visually impaired students during practical classes and which can boost the performance of both educators and students in their respective use of the assistive technology for teaching and learning. This requires guidelines for using the most appropriate assistive technology. Thus, their academic performance can improve, especially in practical classes.

### 6.5 Development of an assistive technology framework

The factors influencing assistive technology for visually impaired students in two South African institutions of higher learning were revealed through the analysis of qualitative data (chapters 5 and 6), as presented in Table 7.1. To gain a deeper understanding of how the influencing factors manifest into attributes, CT was applied in the interpretation. This was conducted by associating the influencing factors with the components of CT, as shown in Table 7.2. Based on the interpretation, the influencing factors' attributes were revealed, which are presented in summary in Table 7.3. This is the third step towards the development of a framework to guide the use of assistive technology for visually impaired students for learning purposes in practical sessions or classes in higher education institutions in South Africa.

Attributes are entities of actions, which describe the function, including the quality of their impacts. This means that attributes result from breaking down concepts for ease of understanding. According to Lin et al. (2025), attributes enhance understanding and facilitate identified processes. Polyn (2024) defines attributes as characteristics that describe an object or subject, including human action. Lin et al. (2025) emphasised the importance of selecting attributes that distinguish characteristics for a clear understanding based on personal experiences.

**Table 7.3: Manifestation of Attributes from Findings**

| Step Four: Association of CT, Findings and Attributes | | |
|---|---|---|
| CT Components | Findings from the analysis | Attributes |
| Structure | Governance | Policy, Standard, Principles |
| | Levels of stakeholders | Skills, Structure, Alignment |
| Environment | Requirements | Technical and Non-technical |
| | Complexity | Ease of use, Access |
| | Culture | Affiliation, Facilitation |
| Strategy | Obligatory approach | Rules, Roles, Responsibilities, Structure |
| | Strategic intent | Selection, Acquisition, Alignment |
| Performance | Training | Knowledge, Skills, Awareness, and Know-how |
| | Operational capability | Technical function, Systems specification |
| | Collaboration | Interaction, Relationship, Alignment |

The influencing factors and their attributes help to formulate guidelines on how to use assistive technology to support visually impaired students in practical sessions or classes, and how assistive technology can be used by educators to assist visually impaired students in practical

sessions or classes. An understanding of these attributes guides the educators on the boundaries and know-how of the assistive technology.

These attributes can be used to formulate guidelines for the stakeholders in selecting and using the most appropriate assistive technology. For example, the guidelines provide baselines for technological specifications and standardisation, which facilitates the selection and use of the assistive technology. Additionally, the attributes, through the technology's guidelines, offer criteria for the training content and scope for developing knowledge and skills about assistive technology. The know-how can be aligned to understand technical and non-technical requirements governed by policies to support inclusive learning. Educators can collaborate with other stakeholders, especially the visually impaired in using assistive technology. The ease of use of assistive technology can encourage and guide educators to facilitate practical classes for both sighted and visually impaired students with confidence.

### 6.5.1 An assistive technology framework

This section presents an assistive technology framework (ATF) for visually impaired students. The framework was developed based on the analysis of the data gathered from two case studies, and the findings were subsequently interpreted. The steps leading to the framework are illustrated in Table 7.1, Table 7.2 and Table 7.3. The factors that define an appropriate assistive technology for visually impaired students are contained in Table 7.2 and Table 7.3 presents the attributes that connect or link the factors. In addition, the relationships between the factors are identified through attributes. The attributes are indicative of the manifestations of the factors. Thus, from a constructivist perspective, the factors and attributes were combined to develop an assistive technology framework, as shown in Figure 7.2.

The ten factors shown in step two, Table 7.2, which were revealed from the data analysis of both cases are interconnected, as shown in the developed framework (Figure 7.2). The influencing factors are governance, training, culture, requirements (non-technical and technical requirements), complexity, strategic intent, operational capability, obligatory approach, collaboration and levels of stakeholders. Based on the data analysis and interpretation of the findings, the factors critically influence the selection of the most appropriate assistive technology for visually impaired students.

The factors manifest into attributes in the process of selecting or using the assistive technology. This was revealed from the data analysis, and the findings were interpreted in previous chapters, 5 and 6. The interrelationships and links between the influencing factors are shown using captioned arrows. The combination of both factors and attributes was to ensure a holistic coverage and affirm appropriateness in selecting assistive technology for visually impaired students.

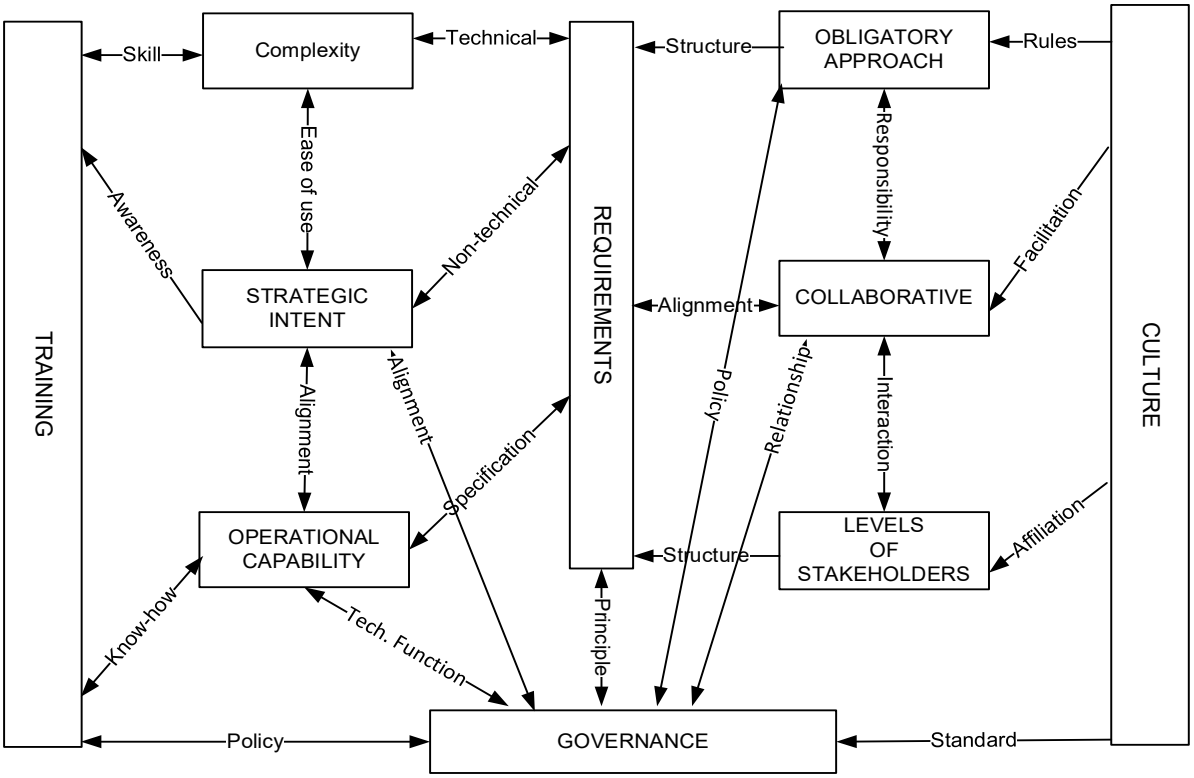


**Figure 7.2: An assistive technology framework**

These influencing factors are briefly discussed to highlight their importance. From bottom-up, governance is used to guide the comprehension of functions and processes (Pye et al., 2024). In higher education institutions, governance guides the stakeholders, ensuring scope and boundaries, through policies and standards. Yang et al. (2025) argued that policy effect is influenced by factors and reduces digital divide. Thus, policies are used to guide stakeholders for collaborative activities aimed at achieving the organisational objective of selecting the most appropriate assistive technology for visually impaired students. In selecting assistive technology for visually impaired, there are various interest groups (stakeholders), from visually impaired students to the institution's management and IT specialists.

Different levels of stakeholders focus on their roles and responsibilities, which Hagoug (2024) associated with the strategic intent to facilitate and select the most appropriate assistive technology to fulfil the needs of visually impaired students during practical classes. As a result, the stakeholders adapt at different levels to complement each other within the organisational structure to take decisions that influence the strategic intent (Osorio et al., 2025). Thus, the stakeholders' decisions have impact on the selection of assistive technology for visually impaired students, from different levels. This makes collaborative effort a critical influencing factor in selecting assistive technology for visually impaired students. Yang et al. (2025) suggest that collaborative effort creates a sharing platform to promote integration and optimise resources, including knowledge.

Collaboration improves social learning in accessing quality educational material (Kija & Mgumba, 2024). Decision making for selecting the most appropriate assistive technology occurs through communication and collaborative engagement between stakeholders. Learning material must be accessible without any complexity for educators and visually impaired students relating to assistive technology (Kafouros et al., 2025). There is a need to understand what is required to eliminate complexity. The focus of higher education institutions is teaching and learning. According to Wolhuter and Lang (2021), it is therefore important to expose students to different activities without discrimination. In the context of this study, not selecting an appropriate assistive technology can be seen or interpreted as discriminatory. This enforces the crucial need for understanding strategic intent as an influencing factor.

From the strategic perspective, stakeholders are expected to follow an obligatory approach to select the appropriate assistive technology to comply with roles and responsibilities that align with the needs of visually impaired students. Based on the criticality of alignment, it is essential to employ an obligatory approach to enact stringency that ensures selecting the most appropriate assistive technology for visually impaired students. Hayes and Proulx (2023) emphasised that teaching is obligatory to enhance students' development with inclusive education through intense support.

Thus, stakeholders present an obligatory approach to develop sustainable education inclusive of all through innovation (Osorio, 2025). In addition, it is significant for stakeholders' collaboration, guided by the policy, to influence performance which benefits both educators and visually impaired students; thus promoting the new normal of teaching through assistive technology that attracts more visually impaired students in the future. Cory (2024) indicated that strategic obligation enhances innovative capability that influences effective teaching and learning.

Requirements, training, and culture crucially influence the selection of assistive technology. There are technical and non-technical requirements when selecting the most appropriate assistive technology. The requirements must always be a perfect fit to a specific environment (Iyamu, 2024). Extensive skills training is essential to sustain and provide adequate services to visually impaired students during practical classes. Thus, continuous training capacitates and ensures that stakeholders can interact with visually impaired students when using the most appropriate assistive technology.

As a result, operational capability manifests from training and awareness of assistive technology. Successful implementation of the most appropriate assistive technology for

visually impaired students encourages cultural fit for stakeholders to embrace technological opportunities or challenges. Culture within an organisation improves competitive advantage (Tadesse Bogale & Debela, 2024). This includes the manifestation of guidelines to facilitate ease of use and access to assistive technology for visually impaired students during practical classes.

### 6.5.2 Guidelines for applying the assistive technology framework

The guidelines for applying the assistive technology framework (ATF) cover the ten factors that influence and shape the framework. As shown in Figure 7.2. each of the factors has its roles and functions as follow:

i. Develop a governance template that can be used to guide the selection of the assistive technology.
    a. The governance template covers policy, standard, and principle.
ii. Create training modules that can be used to bridge the skills gaps. This should help with the types of knowledge required in selecting and using assistive technology.
iii. Develop a template that can be used to gather technical and non-technical requirements for selecting and using assistive technology.
iv. Develop a cultural norm that focuses on visually impaired students and expresses collective value of the environment.
v. Develop a template that highlights the operational capability on how to select and use assistive technology for visually impaired students.
vi. Develop a template that identifies the strategic intent that can be used to select the assistive technology.
vii. Create a complexity document that highlights the potential risk associated with skills and technical functions of selecting assistive technology.
viii. Formulate a structure that stipulates various levels of stakeholders to which roles and responsibilities can be assigned.
ix. Develop a memorandum of understanding that defines stakeholders' collaboration in participating in the selection of assistive technology for the visually impaired students.
x. Develop an obligatory policy that allows stakeholders to deviate from the processes outlined above.

## 6.6 Summary

The chapter presented the findings (factors) drawn from the data analysis presented in chapters 5 and 6. The interpretation of the findings was guided by the contingency theory, using the four components of the contingency model. Through interpretation, four steps were formed, which started with mapping the findings from two cases (OCTVET and MUT) to the final list of findings. The next step is associating the findings with the four components of CT,

which finally manifested into attributes. The process derived from all the steps helped to develop a framework to guide the selection of appropriate assistive technology for visually impaired students in institutions of higher education in South Africa.

# CHAPTER EIGHT
# CONCLUSION AND RECOMMENDATIONS

## 7.1 Introduction

This chapter concludes the study. The study's aim was to develop an assistive technology framework to aid visually impaired students in higher education institutions in South Africa to learn in practical sessions or classes. As discussed in Chapter 3, two South African academic institutions, Mzanzi University of Technology (MUT) and Orange City Technical Vocational Education and Training College (OCTVET) were used as case studies. Data was collected using the semi-structured interview technique. This was to empirically identify factors that guide the selection of the most appropriate assistive technology for visually impaired students in practical sessions or classes. The data were analysed and interpreted using two theories, diffusion of innovation and contingency theory as lenses, respectively. The factors presented a better understanding to develop a framework to guide the selection of an appropriate assistive technology.

The structure of the chapter is as follows; the first section is the introduction. The second section presents an evaluation of how the study achieved its aim. The third section focuses on the contribution of the study. This is followed by the fourth and fifth sections with the recommendations and limitation of the study. The sixth and seventh sections present the benefits of the study with suggestions for further research. The last section concludes the chapter with the summary of the study.

## 7.2 Summary of the chapters

The study requires the evaluation of research. It is important to revisit the objectives of the study to evaluate the impact of the findings. According to Iyamu and Shaanika (2019), a study can be evaluated using the prefixes: What? Who? Why? When? Where? and How? (5Ws and H). Dane (2010) emphasises that it is important to evaluate research at the end to ascertain the quality of the outcome, including the methodology applied. The author further recommends the use of 5Ws and H. Research evaluation can produce both negative and positive outcomes (Dane & Carhart, 2023). The evaluation of this study is twofold. Firstly, it is summarised, as presented in Table 8.1. The second part is an explanation of how the objectives were achieved.

### 7.2.1 Summary of the study's evaluation

The summary of the study's evaluation is to comprehend the processes undertaken by revisiting the objectives of the study. This was done using the six components (5Ws and H) to guide the evaluation. The summary of the study's evaluation is presented in Table 8.1 below.

**Table 8.1: Evaluation of the study**

| Components | Evaluation |
|---|---|
| WHAT was the study about? | The study focused on developing an assistive technology framework (Figure 7.2) for visually impaired students. This was because visually impaired students were experiencing problems. Also, it was difficult to find an institution that had a framework or strategy through which they could select assistive technology. The framework can be used to guide the selection of the appropriate assistive technology for the visually impaired students, especially during their practical classes. |
| WHY was the study conducted? | The study was triggered by the challenges many visually impaired students were experiencing because of inappropriate assistive technology. As articulated in the research problem section, in Chapter 1, these challenges were affecting visually impaired students in accessing academic materials in many South African higher education institutions, especially during practical subjects. The literature corroborated the impact of these challenges. |
| HOW was the study conducted? | Research methodology steps were followed as discussed in detail in Chapter 3, beginning with philosophical assumptions: ontology and epistemology. Other approaches, methods and techniques included the interpretive, inductive qualitative methods. The case study approach was employed as a research design based on which two South African academic institutions, MUT and OCTVET were selected, and the semi-structured interview technique was used for the data collection. Two theories, diffusion of innovation (DOI) and contingency theory (CT) were employed as lenses to guide data analysis and interpretation of the findings, respectively. Based on the findings and interpretation of the findings, a framework (Figure 7.2) was developed. |
| WHO was involved in the study? | From both institutions (MUT and OCTVET), four categories consisting of individuals participated in the study. These included educators, visually impaired students, management, and IT specialists. The participants were selected using a set of criteria discussed in Chapter 3. The participants were categorised as stakeholders taking part in the selection of assistive technology. As discussed in Chapter 3, this was to enrich the quality of the data. |
| WHERE was the study conducted? | The study was conducted using two South African higher education institutions, MUT and OCTVET. As discussed in Chapter 3, a set of criteria was used in selecting the two institutions. Pseudonyms were used to represent the institutions because of the right to privacy; therefore, |

| | |
|---|---|
| | adhering to ethics. In both institutions, the participants included IT technicians, academics, disability managers, and visually impaired students. |
| WHEN was the study conducted? | The study was conducted within three years, which is the prescribed period for the doctoral programme at Cape Peninsula University of Technology. The study was problematised in 2023. Data were collected from the institutions from July 2024 to November 2024. Data analysis began immediately after the data collection was complete, from December 2024 to May 2025. The reason was to eliminate the gap or time difference that could influence the data at hand, and when the data were still fresh in the researcher's memory. Thereafter, the thesis write-up began and was completed in August 2025. |

### 7.2.2 Achieving the study's aim and objectives

The aim of the study was to develop an assistive technology framework to aid visually impaired students in higher education institutions in South Africa to learn in practical sessions or classes. To achieve the aim, the study adopted the interpretive approach. This was influenced by the subjective meaning of different viewpoints from the data analysis of both cases and the interpretation of the findings. The framework was developed from the revealed factors and attributes. The process was a building block of elements described in Table 7.1, Table 7.2 and Table 7.3 respectively. Thus, these elements were used to develop the assistive technology framework through connecting arrows to emphasise the relationship and how they influence each other in selecting the appropriate assistive technology.

The Objectives

To achieve the aim, objectives were formulated as stated in Chapter 1 and revisited in Chapter 3. How the objectives were achieved is discussed below.

**I. To identify factors that can guide the selection of the most appropriate assistive technology for visually impaired students in practical sessions or classes.**

Several steps were followed. Firstly, questions were formulated to collect empirical data from the participants. Secondly, qualitative data were collected, as explained in Chapter 3. In the third step, the diffusion of innovation (DOI) theory was applied as a lens to guide the data analysis using an interpretive approach. Data analysis of the two cases is presented in chapters 5 and 6, respectively. Thereafter, the factors that can influence the selection of the most appropriate assistive technology were revealed from the analysis of data collected from the two institutions. These steps are discussed in chapters 3, 4, 5, and 6. The factors were mapped against each other to identify and remove duplicates. As shown in Table 7.1, ten

factors were identified as follows: 1. Training; 2. Governance; 3. Requirements; 4. Obligatory approach; 5. Complexity; 6. Strategic intent; 7. Operational capability; 8. Collaboration; 9. Culture; and 10, Levels of stakeholders.

The factors were further interpreted using the Contingency Theory (CT). This was purposely to ascertain the attributes of the factors. Table 7.2 presents how the factors were associated with the components of CT. The interpretation revealed how the factors can manifest themselves through the attributes to influence the selection of the most appropriate assistive technology for visually impaired students.

The influencing factors are categorised into technical and non-technical groups, as shown in Table 8.2. This was to gain a deeper understanding of the relationship between the technical and non-technical factors and how they influence the selection of the most appropriate assistive technology for the visually impaired students. Also, the categories help to understand the sources and roles of information related to the factors as they transit from one group of stakeholders (managers, educators, IT technicians and visually impaired students) to another. Table 8.2 below illustrates both technical and non-technical requirements from the revealed factors.

**Table 8.2: Technical & Non-technical factors**

| Technical factors | | Non-technical factors |
|---|---|---|
| Complexity | | Training |
| (Technical) requirements | | (Non-technical) requirements |
| Operational capability | | Culture levels of stakeholders |
| Strategic intent | | Levels of stakeholders |
| Governance | | Obligatory approach |
| | | Collaboration |

Thus, these factors were identified as essential in the process of selecting the most appropriate assistive technology for the visually impaired. The factors were further interpreted to make sense out of them, and the attributes were formed. Both factors and attributes have an impact on the selection of the assistive technology. Some of the technical and non-technical factors such as governance, training, requirements and culture with their attributes, illustrated in Chapter 7, Table 7.3 indicate how the acquired information was used for interaction with assistive technology stakeholders. Collaboration of stakeholders with relevant skills that align with the relevant requirement enhanced the selection.

Stakeholders were working in silos to take the decision to select any assistive technology that is introduced for the visually impaired students. Thus, the available assistive technology did not fulfill the needs of the visually impaired students, especially with practical classes. To ensure that stakeholders are involved and comply with governance, they need to embrace the organisational culture where visually impaired students are concerned. Stakeholders' involvement influences individual behaviour and enhances their performance in relation to the selection of assistive technology for visually impaired students tailored for practical classes.

**II. To determine the factors that could influence the use of assistive technology by visually impaired students and those supporting them.**

The framework (Figure 7.2) presented in Chapter 7 should be applied to guide the use of assistive technology for visually impaired students. The framework contains factors and attributes, which provide guidelines for the users. For example, the framework entails rules and technical functions. Assistive technology is imposed on the visually impaired students without any knowledge about the functionality or training. Visually impaired students are forced to use assistive technology without any guidelines because there are no alternative devices that can facilitate teaching and learning. Thus, some visually impaired students find it difficult to utilise available assistive technology. Factors and manifested attributes in Chapter 7, Table 7.3, provide policies, principles and standards that serve as an obligatory guideline for visually impaired students as a point of departure when interacting with assistive technology.

The training facilitators emphasised the importance of adhering to rules, roles, and responsibilities to maintain access and ease of use of assistive technology. The guidelines eliminate the complexities of using assistive technology to improve performance. Thus, the focus is to close the gap that denies visually impaired students access to assistive technology. The guidelines focus on changing the behaviour of stakeholders, especially visually impaired students, in accessing and using assistive technology for their practical classes. Despite the focus on visually impaired students in practical classes, management, as decision makers, develop intervention strategies that guide the selection of assistive technology intending to receive positive feedback towards better performance.

**III. How can the assistive technology framework be applied by visually impaired students and those that support them?**

An understanding of the factors that influence the most appropriate assistive technology determines how the technology can be used by educators. Students' performance is based on how educators facilitate classes focusing on the subject content. It is different for visually impaired students because educators must be capable of engaging with assistive technology.

Extensive training serves as a priority for educators to understand the use of assistive technology to provide support to visually impaired students, especially with practical classes. Despite the challenges with training provision, collaboration with other stakeholders is necessary for educators to access learning materials in a format that benefits visually impaired students for seamless teaching, especially with practical classes.

Consistent strategic support, including competency training, is needed from management for both educators and visually impaired students towards teaching and learning, using assistive technology. Collaboration and engagement with different levels of stakeholders provide direction in eliminating the complexity of using the assistive technology. For educators to use assistive technology effectively, there must be an alignment between the technical functionality and the systems specification of the institution. In addition, educators' attitude towards the use of assistive technology improves through the influence of other stakeholders. Thus, the use of assistive technology embraces the teaching culture. In addition, educators' involvement in the selection of assistive technology motivates performance that fits visually impaired students and develops their confidence, especially during practical classes.

## 7.3 Contributions of the research

Based on the aim and objectives, as discussed above, the research contributes to the body of knowledge. These contributions are divided into three: theoretical, methodological, and practical. The details are presented as follows:

### 7.3.1 Theoretical contribution

Theoretically, the study contributes to the body of knowledge from three perspectives: DOI, society, and literature. The study contributes towards the advancement and use of diffusion of innovation theory in qualitative and IS research. In the study, the contribution is pinned on how the theory was applied to identify ten factors and their manifested attributes to be used by stakeholders (visually impaired students, IT technicians, educators, and management) in collaboration to select the most appropriate assistive technology for visually impaired students during practical classes.

The development of an assistive technology framework contributes to the body of knowledge and to societal development through the support it can provide to visually impaired students. The framework depicts the association between factors and attributes, and how they influence each other to select, use and formulate guidelines towards the assistive technology. Also, the study highlights the use of diffusion of innovation in conjunction with assistive technology for visually impaired students. Thus, the existing frameworks do not focus on the selection of the most appropriate assistive technology for visually impaired students, especially for their practical classes.

The study adds to existing literature. Before the study was conducted, it was difficult to find empirical studies on the selection of assistive technology for visually impaired students. Also, it adds to the use of DOI and CT in the fields of information systems and information technology.

### 7.3.2 Methodological contribution

Methodologically, the study contributes towards the use of diffusion of innovation and contingency theory as lenses. The theories were applied separately. One was used to guide analysis and the other to interpret the findings.

The use of the two theories in the same study is a significant contribution to the application of sociotechnical theory and field of information systems research. This is because the theories add theoretical grounding and rigor to the study, which is required at the doctoral level. Without the theories, it would have been difficult to examine both technical and non-technical factors at the same time in the study.

The data analysis and interpretation of the findings using DOI and CT, respectively, helped to reveal the influencing factors. The factors bring a fresh perspective for higher education institutions to understand the processes and procedures for selecting the most appropriate assistive technology for visually impaired students, especially for practical subjects.

### 7.3.3 Practical contribution

How the developed framework contributes to the study is illustrated in Chapter 7, Figure 7.2. For practical use, the framework has an impact on stakeholders (visually impaired students, IT technicians, educators, and management). Educators will start to understand how well assistive technology can be used to assist visually impaired students in their practical classes. The framework can be used to encourage most educators to be competent in facilitating practical classes for visually impaired students or how to handle inclusive teaching and learning. IT technicians can understand the processes and procedure from acquisition to implementation which can make it easy to provide support and install and maintain the system. Management plays an important role in facilitating collaboration between stakeholders.

Thus, involvement in strategic decision can influence the selection of the most appropriate assistive technology. Furthermore, strategic intent promotes institutional culture, especially towards social change in the classroom. The guidelines can assist both visually impaired students and educators to use the assistive technology with or without prior knowledge. Thus, the guidelines eliminate barriers and allow visually impaired students to have a choice from various disciplines of study or careers, especially where there are practical classes.

## 7.4 Limitations of the study

The study identified the following three limitations.

i. The study did not focus on all higher education institutions in South Africa, which means traditional universities were not included. The selection for this study was centred around the University of Technology and Technical and Vocational Education and Training.

ii. The study is centred only on totally blind students who have practical subjects, which means other types of visually impaired students in higher education institutions were not included. This does not include other fields of study areas as well.

iii. Various assistive technologies are available and are being used by visually impaired students. However, the focus is only on the most appropriate assistive technology to assist in practical classes.

## 7.5 Recommendations

The study's aim and objectives were achieved through the process of data analysis and interpretation of findings. However, the study revealed some gaps. Recommendations based on the gaps are presented as follows.

### 7.5.1 Training and awareness

Lack of training has been identified as a gap in the study. Training is essential to all higher education institutions to increase success rate. Training is a learning method of gaining information, skills, and talent to perform effectively (Nguyen & Duong, 2021). Nzimakwe and Utete (2024) emphasise that training is significant to enhance organisational productivity through knowledge, skills, and abilities to carry out new activities. Training is about processes directed by strategic intent where people develop competencies to enhance performance. Stakeholders work in isolation to assist visually impaired students with assistive technologies, especially management when making the decision to select assistive technology for the institution.

Stakeholders are aware of visually impaired students and assistive technology. However, they do not know and understand its functionality or how it can be used to support the students. Assistive technologies are presented in different formats; high-tech and low-tech, that comes with their own complexity, and both are being used by visually impaired students. Not all these assistive technologies fulfil the need of the students. Training capacitates stakeholders in terms of understanding the functionality of assistive technology and the needs of visually impaired students better.

Collaboration between stakeholders contributes to the decision-making process when the selection of the most appropriate assistive technology is needed for inclusive learning, especially with practical classes. Adequate training simplifies engagement between service providers and stakeholders during the launch of different assistive technologies. Training increases the know-how and eradicates discrimination in teaching and learning. Continuous training must be ongoing to keep up with the rapidly evolving technology.

### 7.5.2 Governance

Higher education institutions in South Africa are regulated and monitored by the Department of Higher Education and Training (DHET). The department is responsible for developing and implementing policies across higher institutions (DHET, 2018). However, each institution develops its internal policies and strategic operational plan. The findings revealed that higher education institutions comply with the policy of inclusive learning by enrolling visually impaired students. The challenges are the lack of policies and procedure on how to select the most appropriate assistive technology for the visually impaired students. The most appropriate assistive technology can assist visually impaired students with teaching and learning because they are currently experiencing difficulties with practical subjects, which includes the complexity of accessing the devices.

The higher education institutions' policies are not aligned, and the consequences can result in selecting any available assistive technology that might not fulfil the needs of visually impaired students, especially with practical subjects. Also, most visually impaired students repeat the subject or drop out from the university because there is no solution to overcome their challenges especially with practical subjects. Thus, the support from other stakeholders is minimal. To mitigate these challenges, higher education institutions must establish proper governance that can influence collaboration. The policies and guidelines must be accessible by all in real time in archives. In addition, it can promote organisational culture to facilitate guidance for effective performance. The appropriate tools can improve the through-put of visually impaired students, and stakeholders can share their skills with positive attitude and behaviour towards the assistive technology.

### 7.5.3 System base or repository

Each higher education institution in South Africa has an obligation to provide services to visually impaired students. Assistive technology is the solution that needs to be in place for inclusive education to accommodate visually impaired students, especially with practical classes. Higher education institutions need a framework that will be part of the institutional programs that guide the process of selecting the most appropriate assistive technology. The program will enhance and simplify the process of accessing the system through the guidelines to the stakeholders. This program must be in the institutional system to enhance the quality of

education for all. The availability of the framework will eliminate obstacles related to the selection and highlight the ease of use through the guideline. Thus, it must be institutional practice to integrate this program and provide training to stakeholders on how to use it. In addition, this program will be accessible to all, as it is essential for the know-how.

## 7.6 Further study

The study comprehensively focused on achieving the aims and objectives as stipulated in chapters 1 and 3. The framework was developed, with some areas identified for further research, such as where another study can apply a different socio-technical theory like the technology acceptance model. This technology can assist in evaluating how well visually impaired students accept and use the new technology for their practical classes. The technology acceptance model, according to Davis and Venkatesh (1986) and Iyamu (2021) explores the perception of the new technology and the intended user behaviour. Thus, the ease of use determines the technology solution.

## 7.7 Summary

The chapter outlined the summary of the study. Findings were derived from the data analyses in chapters 5 and 6 and the findings were interpreted in Chapter 7. A framework was developed based on the factors and attributes discovered. This chapter revisited the objectives discussed in chapters 1 and 3 to determine that all objectives were achieved. The three-fold contribution of the study was presented, and recommendations and benefits were discussed. Lastly, the focus areas for further studies were presented.

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# APPENDICES

## 9.1 APPENDIX A: INDIVIDUALCONSENT LETTER

Cape Peninsula
University of Technology

FID/REC/ICv0.1

**FACULTY OF INFORMATICS AND DESIGN**

**Individual Consent for Research Participation**

**Title of the study:** An Assistive Technology Framework for Visual Impairment Students in South African Higher Education Institutions

**Name of researcher:** Magdeline Mmapula Gama
Contact details: email: magd.mashilo@gmail.com phone: 0833084506

**Name of supervisor:** Prof Tiko Iyamu
Contact details: email: iyamut@cput.ac.za phone: 0716770300

**Purpose of the Study:** To develop an assistive technology framework, for visually impaired students, for learning purposes in practical sessions or classes in higher education institutions in South Africa.
To identify factors that will guide the selection of the most appropriate assistive technology for visually impaired students in practical sessions or classes.
To provide guidelines on how to use assistive technology for visually impaired students in practical sessions or classes.
To determine how assistive technology be used by educators, to assist visually impaired students in practical sessions or classes.

**Participation:** Participation will consist essentially of educators, visually impaired students and IT technologist).

**Confidentiality:** I have received assurance from the researcher that the information I will share will remain strictly confidential unless noted below. I understand that the contents will be used only for the study and that my confidentiality will be protected.

**Anonymity:** I will be protected in the following manner (unless noted below) the study will not mention any identification of the participants.

**Conservation of data:** The data collected will be kept in a secure manner at CPUT: Data Management Plan.

**Voluntary Participation**: I am under no obligation to participate and if I choose to participate, I can withdraw from the study at any time and/or refuse to answer any questions, without suffering any negative consequences. If I choose to withdraw, all data gathered until the time of withdrawal will be destroyed. Unless the researcher seek permission to use collected data.

**Additional consent:** I make the following stipulations (please tick as appropriate):

| | **In thesis** | **In research publications** | **Both** | **Neither** |
|---|---|---|---|---|
| My image may be used: | | | | |
| My name may be used: | | | | |
| My exact words may be used: | | | | |
| Any other (stipulate): | | | | |

**Acceptance:** I, (print name)_____

agree to participate in the above research study conducted by Magdeline Mmapula Mashilo*)* of the (Faculty of Informatics and Design: Information Technology) at the Cape Peninsula University of Technology, which research is under the supervision of Prof Tiko Iyamu*.*

If I have any questions about the study, I may contact the researcher or the supervisor. If I have any questions regarding the ethical conduct of this study, I may contact the secretary of the Faculty Research Ethics Committee at 021 469 1012, or email naidoove@cput.ac.za.

Participant's signature: _____ Date: _____

Researcher's signature: _____ Date: _____

## 9.2 **APPENDIX B: ETHICAL CLEARANCE**

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**Office of the Research Ethics Committee**
Faculty of Informatics and Design
Room 2.09
80 Roeland Street
Cape Town
**Tel: 021-469 1012**
**Email: ndedem@cput.ac.za**
**Secretary: Mziyanda Ndede**

8 April 2024

Magdeline Mashilo
c/o Department of Information Technology
CPUT

**Reference no:** 231235526/2024/3

**Project title**: An Assistive Technology Framework for Visual Impairment Students in South African Higher Education Institutions

**Approval period:** 8 April 2024 – 31 December 2025

This is to certify that the Faculty of Informatics and Design Research Ethics Committee of the Cape Peninsula University of Technology approved the methodology and ethics of Magdeline Mashilo (231235526) for Doctor of Technology: Information Technology.

Any amendments, extension or other modifications to the protocol must be submitted to the Research Ethics Committee for approval.

The Committee must be informed of any serious adverse event and/or termination of the study.

**Prof L.J. Theo**
**Chair: Research Ethics Committee**
**Faculty of Informatics and Design**
**Cape Peninsula University of Technology**