



University of Venda

**A FRAMEWORK FOR INTEGRATING ADAPTIVE ASSISTIVE
TECHNOLOGIES IN INCLUSIVE EDUCATION: A CASE STUDY OF
THE DISABILITY UNIT OF THE UNIVERSITY OF VENDA**

BY

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A DISSERTATION

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DECLARATION

I, Macheque Vhutshilo, at this moment, declare that this thesis: **A FRAMEWORK FOR INTEGRATING ADAPTIVE ASSISTIVE TECHNOLOGIES IN INCLUSIVE EDUCATION A CASE STUDY OF THE DISABILITY UNIT OF THE UNIVERSITY OF VENDA** for the Doctor of Philosophy in Business Information Systems, submitted to the Department of Management Sciences at the University of Venda has not been submitted previously for any degree at this or another university.

.......... August 2024.....

SIGNATURE

DATE

FULL DISCLOSURE INFORMATION

The work presented in this thesis has led to the following publications.

- **Peer-reviewed journal**

1. **Article Title: Engineering modelling requirements for integration of Assistive Technology as a pathway for inclusive education in the disability unit.** has been peer-reviewed and accepted for publication in the IJRBS's forthcoming issue (Vol 13 No 6, 2024) with a DOI number <https://doi.org/10.20525/ijrbs.v13i6.3529>

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DEDICATIONS

This study is lovingly dedicated to my daughter, Oritonda Macheque, whose inspiration and support have been invaluable.

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ABSTRACT

Integrating Assistive Technologies in inclusive education can enable the academic engagement of students living with disabilities and be transformative from a psychological perspective. However, the success of this endeavour in disadvantaged rural South African universities remains a surmountable challenge due to factors militating against this noble idea. The aim of the study was to conceptualise a framework for integrating assistive technologies in inclusive education at a South African rural university where many students are living with disabilities. The study employed Technology-Task Fit, a variance theory, and DeLone Maclean Information Systems Theory, a process theory as a theoretical underpinning. This study adopts a pragmatism perspective and used an explanatory sequential mixed method design in which quantitative data was collected using an online questionnaire from a convenience sample of seventy-one participants, and the qualitative data was collected from a purposive sample of five participants using face-to-face interviews. Quantitative data were analysed using Statistical Package for Social Scientists (SPSS) Version 29, and results were presented as descriptive statistics, correlation analysis, and chi-square test. Qualitative data were analysed thematically using Atlas ti23. The study found that several factors influenced the integration of assistive devices, but the lack of a proper framework, policies, or guidelines was the most influential. Five requirements for developing the framework were moderating factors, procurement strategies, training strategies, funding strategies, and ATs integration strategies. There was a strong and significant positive association between the requirements at $p < 0.010$ and other demographic characteristics and factors mitigating the integration of assistive devices in inclusive education. From the study, a Framework for Integrating Assistive Technology in Inclusive Education (IAATIE) was developed based on the requirements and best practices documented in journal literature. IAATIE was validated as relevance and acceptance using content (requirements), relevance, and acceptance by most of the reviewers and validators. The academic contribution of the study was the framework for Integrating Assistive Technologies in inclusive education at the university, which encouraged coordinated efforts from various key players, including students who have been previously ignored. The study recommends the implementation of a IAATIE framework for inclusive education.

Keywords: Assistive Technology (AT), Inclusive education (IE), Internet of Things, Big Data & Socio-economic factors.

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LIST OF ACRONYMS

4IR	The Fourth Industrial Revolution
AATS	Adaptive Assistive Technology
ADA	The Americans With Disabilities Act
AI	Artificial Intelligence
AR	Augmented Reality
ASD	Autism Spectrum Disorder
AT	Assistive Technology
CRPD	Convention On The Rights Of Persons With Disabilities
DSA	Disabled Student Allowance
DSR	Design Science Research
DU	Disability Unit
EPRS	European Parliamentary Research Service
HAA	Human Activity Assistive Technology
IAATIE	Integrated Adapted Assistive Technology For Inclusive Education
ICF	International Classification Of Living, Disability, And Health
ICT	Information And Communication Technologies
IDEA	Individuals with Disabilities Education Act
IoT	Internet of Things
IRT	Innovation Resistance Theory
LRE	Least Restrictive Environment
LRE	Least Restrictive Environment (LRE)
PEOU	Perceived Ease-Of-Use
PU	Perceived Usefulness
QUAL	Qualitative
QUAN	Quantitative

STD	Standard Deviation
STOA	Scientific Foresight Unit
SWDS	Students With Disabilities
TAM	Technology Adoption Model
TPB	Theory Of Planned Behaviour
TTF	Task-Technology Fit
UDL	Universal Design For Learning
UK	United Kingdom
UTAUT	Unified Theory of Acceptance and Use of Technology
VR	Virtual Reality
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

This chapter introduces the study and gives the background of the problem, the purpose of the study, the context of the study, research questions and objectives, the study's contribution to the existing knowledge, the significance of the study, and delimitations.

1.1.1 Understanding the Imperative for Assistive Technologies

The purpose of a disability unit in an institution of higher education such as the University of Venda is to provide maximum support to students with disabilities so they can succeed in their academic pursuits. With technological evolution at its peak, assistive teams offer more alternatives in this area, as they have been around for some time. Assistive Technology has been used for various purposes since ancient times Viner, Singh and Shaughnessy (2020). For example, studies by Grönlund, Lim and Larsson (2010) and Akpan, Lawrence and Beard (2013) independently identify inclusive education as one of the prominent areas where ATs have been intensively used to meet the needs of individual students with disabilities. The concept of Assistive Technologies refers to anything that can be used to compensate for the lack of specific abilities, such as primitive devices for aiding walking or writing to advanced devices for hearing, hi-tech devices like brailers and specialised computer software used for reading by people with dyslexia (Beard, Carpenter & Johnson, 2011; Reed & Bowser, 2005; Jay, Brown & Harper, 2011). Previously, the definition of Assistive Technology was published in the Assistive Technology Act of 1998, which superseded and modified the Technology-related Help for People with Disabilities Act of 1998 (also known as the Tech Act) 1998. The Americans with Disabilities Act defines AT as "any item, piece of equipment, or system commonly used to increase, maintain, and enhance the functional capacities of individuals with disabilities, whether acquired commercially, modified, or customised" (Bausch *et al.*, 2005). In recent years, AT has evolved to include hi-tech devices and platforms that can support students in several educational contexts to enhance their academic performance (Asongu & Odhiambo, 2019).

1.1.2 The Role of Technological Advancement

Integrating the fourth industrial revolution and Internet of Things technologies into assistive technology has profoundly transformed education, making it more inclusive and accessible for students with disabilities (Eden et al., 2024). 4IR and IoT technologies directly enhance AT in educational settings through personalised learning systems, advanced wearable devices, interactive classroom environments, enhanced communication tools, and remote learning

solutions; these technologies address diverse educational needs and barriers (Oke et al., 2020). As technology evolves, it is essential to leverage these advancements to create equitable educational opportunities for all students, promoting a more inclusive and supportive learning environment (Roshanaei et al., 2023).

The World Health Organization (2023) views the primary purpose of ATs as to promote the well-being of individuals with disabilities by maintaining or improving their functioning and to enable them to live healthy, productive, independent, and dignified lives so that they take part in education, the labour market, and public life. In this way, institutions of HE seek to use ATs to assist students with disabilities in leading more independent academic lives that allow them to go about their daily routines and carry out a variety of educational and social activities that would otherwise be impossible. For better handwriting, one can use tools such as colour-coded computers, mice with ergonomic designs, and programs that recognise spoken words (Cha & Ahn, 2020). ATs can assist students in enhancing their academic achievement, empowering them socially and economically (McNicholl et al., 2021). Most economies rely on technological advancement, and inclusive education will likely get significant money to acquire ATs that promote inclusive education and generate economically successful pupils. ATs must be positioned worldwide as vital instruments that enable human capabilities, generate new economic activity and jobs, and reduce the financial strain on the healthcare system. According to Edgerton, Roberts and Von Below (2011), economic benefits include enhanced health and quality of life, better education and employment results, and increased productivity.

1.1.3. Institutional Readiness and Cultural Shifts Provision of ATs

Inclusive education is for all students, including those with special educational needs, and is taught in inclusive classrooms in public schools, colleges, and universities (Ahmad, 2015; Akpan, Lawrence & Beard, 2013). Students living with disability face multiple challenges in education and campus life (Swart & Greyling, 2011). Inaccessible classrooms, inability to cope with lecture presentations due to hearing and writing problems, and visual challenges are some examples of barriers to education for students with disabilities. According to Tugli *et al.* (2013), Integrating students with disabilities into higher education institutions involves navigating numerous physical, social, and attitudinal barriers at different stages of their education. Without adequate support services, these barriers can result in social and academic exclusion, as well as increased over-dependence. The United Nations Convention on the Rights of Persons with Disabilities addresses the right to education for people with disabilities. All nations that are part of the CRPD must ensure that people with disabilities have equal access to all levels of education, including basic literacy classes for children and adults, vocational training programs, and universities (Harpur, 2012).

1.2. THE CONTEXT OF THE STUDY

According to Buthelezi (2014), in the higher education system that South Africa's democratic administration inherited in 1994, black disabled learners have historically been and are now particularly vulnerable to exclusion from the education system, which includes higher education. Siwela (2017) prefers that challenged students in South Africa, particularly black challenged learners, have historically been and continue to be disproportionately vulnerable to exclusion from the education system, including higher education (Mazoue, 2011).

The experience of disabled students in higher education shows that inequality levels extend far beyond merely accessing existing provisions within institutions (De Beer *et al.*, 2022). Although gaining access, especially to a career of the student's choice, is fundamental to creating equity for these students, participating equitably in teaching and learning and having a fair chance to succeed remain as crucial as the former imperative (Moleke, 2022).

According to Khanyile (2022) and Ratshitanga (2021), a "higher education institution is any institution that fully, partially, or remotely offers postsecondary education." According to Act 101 of 1997, a private higher education institution may be: (a) registered or provisionally registered as a private higher education institution; (b) declared as a public higher education institution; or (c) established or presumed to be established as a public higher education institution.

1.2.1. Higher education institution:

According to Ratshitanga (2021), the development of public universities and other public institutions of higher education is an attempt by the state to ensure that further education is available and accessible to everyone. Like other public institutions of higher education, universities are founded by Section 20 of the Higher Education Act 101 of 1997. The following are the public universities and technical colleges classified in 1994 according to historical advantages and disadvantages and race of origin Viljoen (2002).

Table 1.2. Classification of Public Universities and Technikons

Categories	Institutions included	Historically advantaged/ disadvantaged
Historically black universities: RSA	<ul style="list-style-type: none"> • University of Durban-Westville • Medunsa University • University of the North • Vista University • University of the Western Cape • University of Zululand 	Historically disadvantaged
Historically black universities: TBVC	<ul style="list-style-type: none"> • University of Fort Hare • North-West University • University of Transkei University of Venda 	Historically disadvantaged
Historically black technikons: RSA	<ul style="list-style-type: none"> • ML Sultan Technikon • Mangosuthu Technikon • Technikon Northern • Transvaal • Peninsula Technikon 	Historically disadvantaged
Historically black technikons: TBVC	<ul style="list-style-type: none"> • Border Technikon • Eastern Cape Technikon • North West Technikon 	Historically disadvantaged
Historically white (Afrikaans) universities: RSA	<ul style="list-style-type: none"> • University of the Orange Free State • University of Port Elizabeth • University of Pretoria • Potchefstroom University • Rand Afrikaans University University of Stellenbosch 	Historically advantaged
Historically white (English) universities: RSA	<ul style="list-style-type: none"> • University of Cape Town • The University of Natal • Rhodes University University of the Witwatersrand 	Historically advantaged

Adopted from Ratshitanga (2021)

Figure 1.1 shows the map of South Africa by province; the University of Venda is found in one of the nine provinces, as shown on the map.

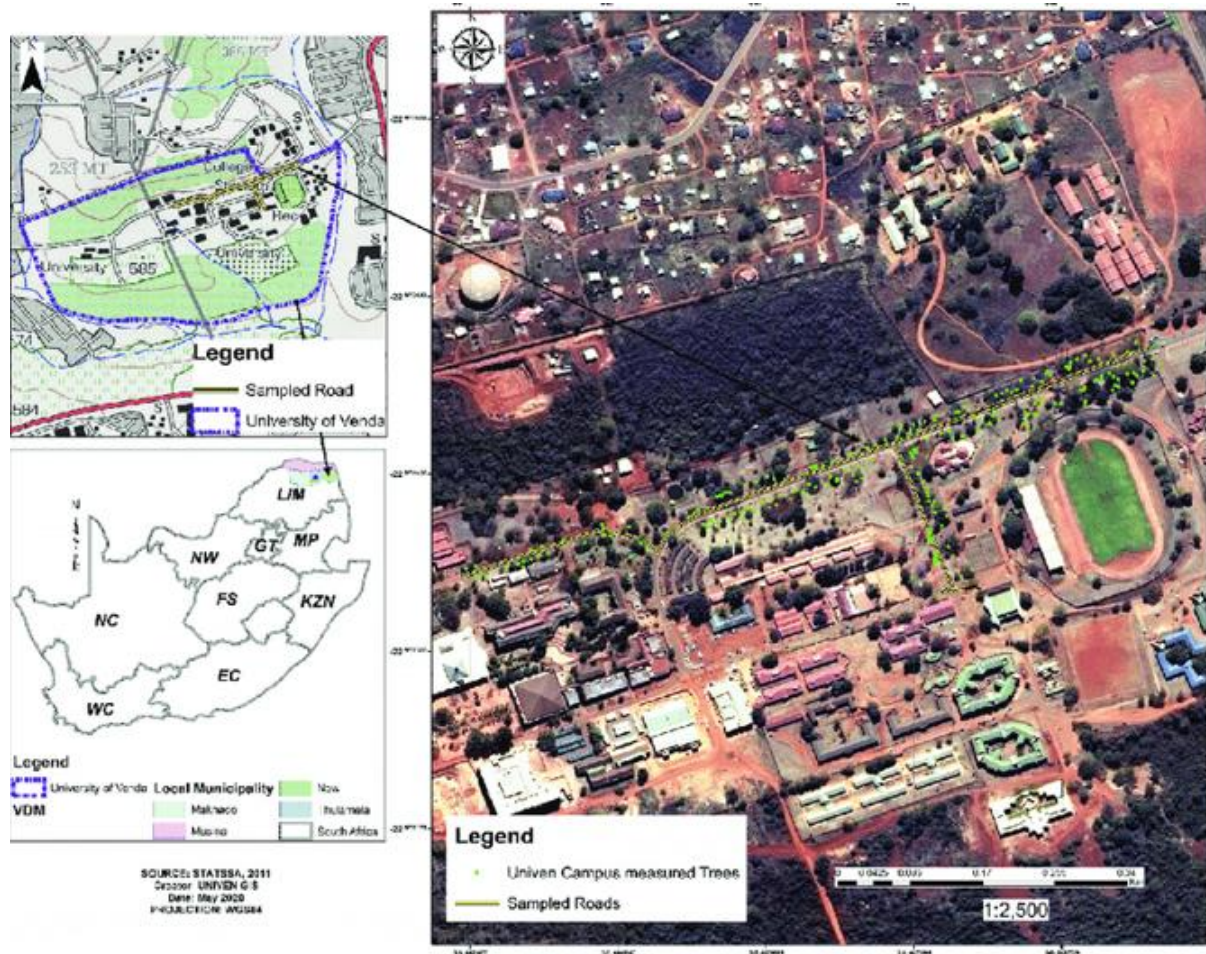


Figure 1. 1: Map of South Africa presenting the location of the University of Venda

The context of this study is the Disability Unit of the University of Venda. The centre is designed to assist students with learning barriers due to disabilities. There is a great need to support students living with disabilities due to the uniqueness of their physiological makeup. The assistance comprises mobility and orientation training to help students become acquainted with their environment, computer training to help students gain the necessary skills for using advanced Assistive Technology, and technical support for visually impaired students with braille printing and scanning of learning material. They train students to use assistive devices and facilitate tests and examination writing centres. There are several challenges that University of Venda students living with disabilities are facing in accessing higher education institutions. However, the challenges these students experience within the institution differ. Some rely on assistive devices, and some do not depend on ATs for learning but have special

needs that require support. These challenges have created learning environments that are chaotic and confusing for students (Habib et al., 2012).

1.3 RESEARCH GAP AND FORMULATION OF THE RESEARCH PROBLEM

The rapid development of emerging technologies significantly impacts teaching and learning around the globe (Grimus, 2020). According to Cha and Ahn (2020), ATs are essential technologies that transform students' learning and collaboration in institutions where they are integrated into education. There is a dire need to use ATs for teaching and learning in higher education to aid students with disabilities in their academic activities. ATs are designed to empower students' learning if adequately integrated, considering students' socio-technical needs. Students living with disabilities experience a range of physical, social, and learning challenges at different stages of their academic period due to a lack of proper support, and this can lead to social and educational exclusion. South African universities have seemingly functional disability units that have been operational for some time and rely on adaptive assistive devices (Khetha, 2017). Some of these universities face many challenges because they are in rural areas where resources can be scarce. The University of Venda is one of the disadvantaged rural universities and its disability unit is the unit studied in this thesis. The problem is that the university lacks a proper framework for integrating adaptive assistive technologies in inclusive education and, therefore, fails to resolve some challenges faced by students with disabilities. In many cases, the unit is unable to cope with new challenges, particularly in catering to needy students and addressing diversity among different types of students living with disabilities within the institution. A framework based on the amalgamation of findings of an empirical study and best practices implemented somewhere else in the world where similar problems were once experienced can go a long way to improve the integration of ATs in the university's disability unit. Therefore, the purpose of the study is to develop a framework for integrating assistive technologies in inclusive education in disability units at the University of Venda.

1.4 OBJECTIVE OF THE STUDY

The major objective of the study was stated as:

To undertake requirements engineering modelling to develop a framework for integrating ATs for inclusive education in the disability unit at a historically disadvantaged South African university

The sub-objective was to:

- a. Explore factors influencing the integration of Adaptive Assistive Technologies in inclusive education at historically disadvantaged South African university
- b. Assess the impact of Adaptive Assistive Technologies on enhancing inclusive education in a historically disadvantaged South African university.
- c. Evaluate the critical socio-technical challenges that prevent students with disabilities from accessing ATs in the disability unit of historically disadvantaged South African universities.

1.5 RESEARCH QUESTIONS

The main research question was:

What are the main requirements for engineering modelling to develop a framework to integrate AT in inclusive education at a disadvantaged South African University?

The minor research questions are:

- a) What is the role of Adaptive Assistive Technologies in enhancing inclusive education at a historically disadvantaged South African university?
- b) What factors are influencing the integration of ATs in inclusive education at a historically disadvantaged South African university?
- c) What socio-technical challenges are faced by students with disabilities in historically disadvantaged universities in South Africa?

1.6 ACADEMIC AND PRACTICAL CONTRIBUTION OF THE STUDY

- The academic contribution bridged the gap in knowledge in ATs integration in inclusive education by applying different theoretical perspectives on a disadvantaged rural university. This is the first attempt to address such a real-life problem with various critical players.
- The scientific contribution of the framework from this study is functional and contains prescriptive knowledge important in IS research. It also provides universities with appropriate guidelines for integrating ATs in inclusive education to improve the academic participation of students living with disabilities.
- The framework developed in this study contributes to the knowledge needed to solve a university's real-world problem of integrating ATs to benefit students.

- The study contributes scientific knowledge to adapted technology practitioners, and the framework has practical applications that can assist the university in identifying militating factors that interfere with integrating ATs.
- This study assists the inclusive educational policy marker in drafting and amending policies that include the inclusive group and also adds value to the Department of Higher Education and Training by identifying the socio-technical challenges faced by students with disabilities in historically disadvantaged universities in South Africa.

1.7 DELIMITATIONS OF THE STUDY

The study was delimited to identify factors influencing the integration of Adaptive Assistive Technologies in inclusive education at historically disadvantaged South African universities, to assess the impact of Adaptive Assistive Technologies on enhancing inclusive education in a historically disadvantaged South African university, to determine the main requirements of a framework to improve the integration of ATs in higher education inclusive education and to develop a framework for integrating adaptive assistive technologies in inclusive education. The study's scope was limited to developing and implementing a framework for integrating adaptive assistive technologies in inclusive education in selected South African universities, in this case, the University of Venda.

1.8 OPERATIONAL DEFINITIONS

This section provides critical terms and concepts that are adopted in this study. The following are the operational definitions of the study:

Assistive Technology is an object, piece of machinery, or product system used to maintain, enhance, or enhance the capabilities of individuals with disabilities, regardless of whether it is modified, customised, or purchased commercially off the shelf (WHO, 2015). However Provisions et al.,2014 defined as a device, software program, or system used to increase, maintain, or improve the functional capacities of people with disabilities. This study adopted the terms AAT and AT interchangeably. This study uses Assistive Technology as an umbrella term for various devices, services, and practices for educational and rehabilitation purposes. It is utilised to address the issues faced by people with disabilities in institutions of higher learning.

Disability in all its forms, carries significant social, emotional, and resource implications for individuals classified as functionally disabled. (World Health Organization, 2011). The medical model defines **disability** as an illness or health condition that impairs an individual's ability to fulfil personal and societal commitments (Lutz and Bowers, 2003.) This definition links

knowledge of this study as assistive technologies are designed for students with special needs.

A **framework** is a structured and organised set of concepts, practices, or guidelines that provides a foundation for approaching a particular task, problem, or domain (Venkatesh, Morris, Davis & Davis, 2003). In this study, a framework is used as a model to facilitate consistency, efficiency, and scalability across a range of activities by acting as a framework for the construction of solutions.

Higher education institution: According to the Higher Education Act 101 of 1997, a 'higher education institution' is defined as any entity offering higher education on a full-time, part-time, or distance basis and meets at least one of the following criteria: (a) it is established or officially recognized as a public higher education institution under this Act; (b) it has been formally declared a public higher education institution under this Act; or (c) it is registered or conditionally registered as a private higher education institution under this Act..

Inclusive education is an approach to schooling that ensures all students, including those with disabilities or special needs, have equal access to quality education in mainstream classrooms, promoting diversity, equity, and respect for individual differences (Graham, 2020). In this study, inclusive education means equal access to quality education for all.

Integration involves combining separate elements, systems, or practices into a unified whole, enhancing efficiency and functionality by enabling them to work together effectively toward a common goal (Hezart, Naik, Araujo, & Watters, 2005). In this study, integration means including assistive technologies in different settings to improve accessibility and inclusivity for people with disabilities.

Process theory seeks to elucidate the dynamic and evolving nature of systems, organisations, or phenomena by analysing the underlying processes, interactions, and mechanisms driving their development and change over time (DeLone & McLean, 1992). The process approach is generally used to answer the "how" questions. Therefore, this study used the process approach to understand how students with disabilities utilise ATs in the disability unit; these could be improved to aid inclusive education and enhance academic and socio-economic participation.

Socio-economic factors relate to the mix of social and economic conditions, like income, education, and access to resources, that affect individuals and communities, shaping their lives and opportunities. (Martins *et al.*, 2012). In this study, socio-economic factors refer to challenges when integrating ATs into inclusive education.

System use typically refers to utilising a particular system, such as software, technology, or organisational framework, to achieve specific objectives or tasks. It involves interacting with the system's functionalities and features to accomplish desired outcomes efficiently and effectively (Fidock and Carroll, 2009). In this study, system use refers to assistive devices used by students living with disabilities.

System perspective is a holistic approach that analyses complex phenomena by examining interactions and interdependencies within systems. The system perspective in this study refers to how students use AT for academic enhancement.

Variance theory describes the interplay between three components at a certain point: technological functionality, task needs, and individual skills (DeLone & McLean, 2008). This study used variance theory to investigate the factors influencing the use of technology for academic purposes by students living with disabilities and the challenges they face.

1.9 STRUCTURE OF THE THESIS

This thesis consists of nine chapters. Chapter 1 introduces the study and gives the background to the problem, the purpose of the study, the context of the study, research questions and objectives, the study's contribution to the existing knowledge, the significance of the study, and delimitations. Chapter 2 presents a literature review from previous studies conducted elsewhere, providing the basis for identifying the knowledge gap regarding adaptive assistive technologies and their uses in inclusive education, the impact of adaptive assistive technologies on enhancing inclusive education, and socio-technical challenges faced by students with disabilities in historically disadvantaged universities in South Africa. Chapter 3 deals with the theoretical underpinning of the study and the framework of the study, which include the variance, the process model, DeLone and McLean Information Systems Success Model, and the framework for the conceptual modelling of Assistive Technology device outcomes.

Chapter 4 provides a thorough description and justification for the research technique employed in this study. It also gives the research methodology, philosophy research designs, research strategy, population and sampling strategies, data collection and ethical consideration of the study. Chapter 5 presents the quantitative results, the Chi-square test of dependence, analysis tools, validity, reliability, and trustworthiness. Chapter 6 presents qualitative analysis. Chapter 7 presents the discussion of findings, this chapter aims to provide a full literature-controlled explanation of the study's findings. Chapter 8 presents the proposed framework development and its components based on the findings of the study and framework

validation. Chapter 9: Conclusions, limitations, and recommendations. This chapter presented the findings of these studies. Figure 1.2 present the structure of the thesis.

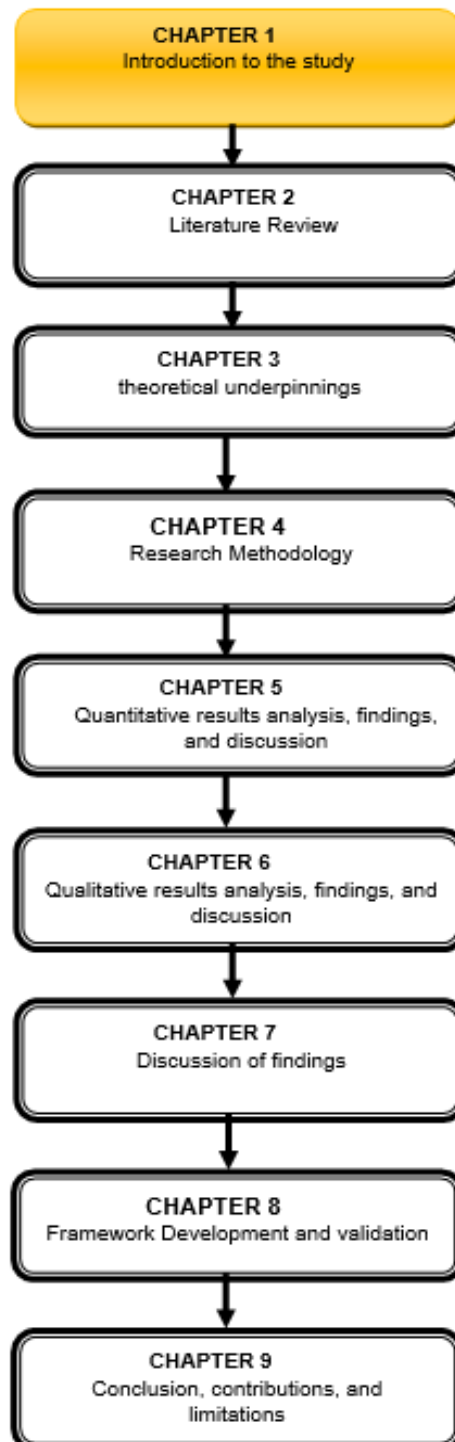


Figure 1. 2: Structure of the Thesis

1.10 SUMMARY

This chapter introduced the research study by providing the background of the problem of assistive devices in universities in general and the University of Venda in particular. The problem has been identified as a lack of a framework for use by the disability unit when dispensing its functions to students living with disabilities. The chapter highlighted the need for developing a framework for the disability unit to improve its services to the students so that they can participate maximally in an inclusive educational environment at the university. The next chapter presents a detailed account and critique of the literature review on scholarly work done in this area by other scholars and theoretical frameworks.

CHAPTER 2: LITERATURE REVIEW

2.1. INTRODUCTION

As a follow-up to the introduction and background discussed in the previous chapter, this chapter provides insights into Adaptive Assistive Technologies concepts. This chapter presents a detailed literature review from previous studies conducted elsewhere, providing the basis for identifying the knowledge gap. The role of adaptive assistive technologies and their uses in inclusive education, the impact of adaptive assistive technologies on enhancing inclusive education, The Fourth Industrial Revolution the Internet of Things are also discussed in this chapter, and the socio-technical challenges faced by students with disabilities are detailed in this chapter.

2.2 THE ROLE OF ADAPTIVE ASSISTIVE TECHNOLOGIES AND THEIR USES IN INCLUSIVE EDUCATION

The umbrella term Adaptive Assistive Technology covers various products to aid people with disabilities (Nierling et al., 2018 & Pousada et al., 2021). These tools are meant to improve or extend human abilities. Regardless of socioeconomic status or differences in power or disability, education is still the most critical element in one's development, empowerment, and equality (Ahmad, 2014). According to Blackhurst (1997: 10), "Assistive Technology consists of devices and services that increase the performance of persons living with a disability by enabling them to complete tasks more effectively, efficiently, and independently than otherwise possible." Several scholars view assistive technologies as any devices, systems, pieces of technology, or software that can enhance, maintain, or augment the functional capabilities of people with disabilities (Chambers, 2020; Edyburn, 2000; Technology, 2010). This implies that Assistive Technology should be a powerful tool capable of addressing several challenges faced by individuals with disabilities by adequately integrating the technology into their academic activities and social being (Sulaimani & Bagadood, 2022). The solace is derived from the fact that individuals living with disabilities have proven over time that they are capable of learning as well as working together at the same level as their non-disabled peers in inclusive education circumstances when provided with equal opportunities to demonstrate their differentiated capabilities effectively (Alquraini & Gut, 2012; Chukwuemeka & Samaila, 2020; Devi & Sarkar, 2019). Some authors view Assistive Technology as adaptive devices, equipment or software intentionally created to support and facilitate special needs education functions in exceptional circumstances (Erdem, 2017; Visagiei, Scheffleri, Seymourii & Mjii, 2020). This view of ATs has led to adaptive technology, a special type of AT tailored for students with special needs (Campado, Toquero & Ulanday,

2023; Rincon-Flores, Vázquez, Sanchez, Solís, Valdes & Lara, 2023). Sulaimani and Bagadood (2022) opine that the increase in the use of AT in teaching and learning to aid students with intellectual disabilities is due to international policies and legislation on the need to be inclusive to cater to those with special needs. The proliferation of studies seeking to understand and advance knowledge in using ATs in an educational context has reinforced the concept of inclusive education and disability units in higher education institutions. Currently, most of the studies use the terms Assistive Technology and adaptive technology interchangeably because the latter is a subset of the former, and other authors argue that most learners with disabilities can use either of the two (Erdem, 2017; Campado et al., 2023; WHO, 2021; Visagiei et al., 2020). In light of this, the World Health Organization (WHO, 2015) defines Assistive Technology widely accepted as an object, piece of machinery, or product system that is used to maintain, enhance, or enhance capabilities of individuals with disabilities, regardless of whether it is modified, customised, or purchased commercially off the shelf. This study uses Assistive Technology as an umbrella term referring to a range of devices, services and practices for educational and rehabilitation purposes. They are utilised to address the issues faced by people with disabilities in institutions of higher learning (Visser et al., 2000; Hubble, Liebenberg, Snyman & Young, 2020).

According to the WHO (2021), assistive and adaptive technologies are intended to enable and promote inclusion and participation, particularly of individuals living with disabilities, ageing populations, and people with non-communicable diseases. The use of ATs or AATs in inclusive education is to sustain or improve the functioning and independence and to promote the well-being of individuals with disabilities so that they live healthy, productive, independent, and dignified lives and participate in education and, ultimately, in the labour market and civic life (Erdem, 2017; WHO, 2021). Much effort is now placed into providing proper inclusive education in higher education, resulting in a shift in perspective that brings with it the necessity and challenge of adapting the means of teaching delivery in inclusive classes to accommodate the wide range of students' educational requirements. It is now imperative for universities that have disability units to have proper frameworks to implement inclusive education to cater to all students with special needs so that they perform well in their studies.

The new perspectives promote the idea that education for students with special needs in inclusive schools becomes a shared responsibility among the many parties involved due to recognising all learners' skills or unequal abilities (Reicher, 2010). A shift in perspective, usability, and accessibility of services, pedagogy, methods, and materials is therefore needed to meet standards for teaching, assessment, and resources. Students at risk of marginalisation and exclusion are targeted as solutions to the pervasive problem of acknowledgement in all forms of education (Standen *et al.*, 2020).

Evidence from the available literature shows that assistive devices have come a long way in providing equal access to schooling (Grönlund, Lim & Larsson, 2010; Devi & Sarkar, 2019; Edyburn, 2000). There are challenges in implementing inclusive education, as evidenced by the current movement in developing nations across Africa, Asia, and Eastern Europe. (Ifeoma *et al.*, 2020).

The use of assistive technologies to aid individuals with special needs in education and workplaces is well-documented, and the effort to improve these facilities to provide better services is on the rise (Blackhurst, 1997; Chambers, 2020; Edyburn, 2000). According to Rashied (2018), several public South African universities seem to have accepted the use of technology-assisted learning tools, such as adaptive learning technology, as an effective method to promote student retention and success because these tools allow the customisation of student learning paths to suit their individual learning needs using technology-assisted learning. When properly implemented, Assistive Technology can enable students to access the general education curriculum by providing them with more ways to complete their assignments and more opportunities to work independently on tasks they may have struggled with. This assertion is supported by McGraw-Hill (2016), who observes that ATs can be beneficial in providing various assistance to all types of learners when carefully applied in higher education, depending on the contexts of the affected students. Many of the most encouraging case studies on inclusive education have come from well-off regions in North America and Western Europe. In a society where people's abilities and expectations vary greatly, this means that using ATs can remove the obstacles that prevent them from learning as much as possible (Grönlund, Lim, & Larsson, 2010).

2.3 HARNESSING CUTTING-EDGE TECHNOLOGIES IN FACILITATING INCLUSIVE EDUCATION

Emerging technologies facilitate inclusive education in the era of Education 4.0, driven by the Fourth Industrial Revolution, cutting-edge technologies are revolutionising education to be more inclusive and accessible than ever (Chigbu *et al.*, 2023). Artificial Intelligence, the Internet of Things Augmented Reality, Virtual Reality and robotics have significantly impacted inclusive education by addressing diverse learning needs and promoting equitable educational environments (Ahmad *et al.*, 2024). Inclusive education aims to integrate all students into general education settings, irrespective of their abilities or disabilities and is increasingly supported by these technological advancements. The Fourth Industrial Revolution has ushered in a range of transformative technologies that offer new opportunities for enhancing educational accessibility and inclusivity (Jardinez *et al.*, 2024).

2.3.1 Enhancements of 4IR and IoT Technologies in AT for Personalised Learning, Accessibility, and Inclusivity

The following subsections address how cutting-edge technologies directly enhance inclusion education.

2.3.1.1. Artificial Intelligence in Personalised Learning

Artificial Intelligence has emerged as a cornerstone of Education 4.0, and one of the most significant impacts of 4IR technologies on education is the development of personalised learning systems. AI-driven adaptive learning platforms are at the forefront of this transformation (Vincent et al., 2020 & Ayeni et al., 2024). These systems analyse students' performance data, learning preferences, and progress in real-time, tailoring educational content and instructional strategies to individual needs (Ezzaim et al., 2024). For students with disabilities, such systems can provide customised resources that align with their unique learning requirements (Dhananjaya et al., 2024). This capability is particularly beneficial for students with disabilities, as AI-powered tools like speech-to-text and text-to-speech applications enhance accessibility to educational content, making learning more inclusive (Zdravkova, 2022).

2.3.1.2. Internet of Things (IoT) for Enhanced Learning Environments

The IoT has facilitated the development of advanced wearable assistive devices that significantly enhance accessibility in educational settings. Smart wearables, such as augmented reality glasses and sensor-based devices, support students with various disabilities (Reyes et al., 2021 & Recalde et al., 2020). For example, smart glasses equipped with real-time audio description capabilities can assist visually impaired students by converting visual information into auditory cues, enabling them to navigate classroom environments and access visual content more effectively (Abdel et al., 2021).

IoT technologies contribute to creating more interactive and responsive classroom environments. Connected smartboards, tablets, and interactive whiteboards facilitate dynamic learning experiences (Niknejad et al., 2020). For students with physical disabilities, these technologies offer alternative ways to engage with educational content, such as using touchless controls or voice commands to interact with digital materials (Ntoa et al., 2022). This proactive approach ensures that educational environments are responsive and supportive of all learners.

2.3.1.3. Augmented Reality and Virtual Reality for Immersive Learning

Virtual reality and augmented reality) technologies offer immersive educational experiences that transcend physical limitations, allowing students, including those with mobility impairments, to engage in virtual simulations and interactive environments (Chen et al., 2023). These technologies promote spatial awareness, hands-on learning, and experiential education, catering to diverse learning styles and enhancing inclusivity in education settings (Khasawneh et al., 2023; Zhang & Zhang, 2024).

The COVID-19 pandemic underscored the importance of remote learning, and IoT technologies have played a crucial role in supporting this shift. Virtual reality and augmented reality technologies, enabled by IoT, offer immersive learning experiences that are particularly valuable for students who cannot attend traditional classrooms (Garlinska al., 2023). For students with mobility impairments or chronic illnesses, VR and AR can provide virtual field trips, simulations, and interactive lessons that would otherwise be inaccessible (Chen et al., 2023).

Augmentative and alternative communication devices have significantly improved due to 4IR and IoT technologies (Farzana et al., 2021). AI-powered speech-generating devices can now adapt to users' speech patterns, learning from their usage to provide more accurate and contextually relevant communication. This adaptability is particularly beneficial for students with speech impairments, as it enhances their communication ability in educational settings (Mitra et al., 2023). Moreover, IoT connectivity allows AAC devices to integrate seamlessly with other educational tools and resources. For instance, a communication device connected to a classroom's smart network can access educational content, participate in online discussions, and interact with other digital learning resources, thus broadening the scope of communication and learning opportunities (Alfoudari et al., 2021)

2.3.1.4. Robotics: Enabling Independence and Skill Development

Robotics technology is revolutionising assistive education by offering crucial support, personalised instruction, and fostering skill development among students with disabilities (Alkhaldeh et al., 2023). Through robotics competitions and workshops, students can showcase their talents, cultivate technical skills, and thrive in inclusive learning environments, promoting greater independence and active participation (Barua et al., 2023). According to Hoogerwerf et al. (2023), Robotics play a significant role in supporting students with disabilities by aiding and promoting independence. Here are some applications of robotics in inclusive education.

- Skill Development

Engaging in robotics competitions and workshops empowers students to develop technical skills hands-on. They learn to build, program, and operate robots, fostering creativity, problem-solving abilities, and technical proficiency crucial for future endeavours.

- Physical Support

Robotics provides essential physical assistance, aiding students with disabilities in tasks that may be challenging independently. From simple actions like fetching objects to more complex tasks such as assisting with mobility or manipulation, robots offer practical help tailored to individual needs.

- Promotion of Independence:

Robotics technology is pivotal in enhancing independence for students with disabilities. It enables them to perform tasks autonomously, fostering self-reliance and confidence in their abilities inside and outside the classroom.

- Enhanced Participation

Robotics competitions and workshops encourage active engagement and collaboration among students with disabilities. These events provide platforms for them to demonstrate skills, compete on equal footing, and gain recognition, thereby bolstering their sense of achievement and belonging (Rodegher et al., 2021).

2.4 THE IMPACT OF ADAPTIVE ASSISTIVE TECHNOLOGIES ON ENHANCING INCLUSIVE EDUCATION

A plethora of literature details the positive contribution of technology in general and ATs in particular to the academic performance of students with disabilities in higher education in South Africa (McGraw-Hill Education, 2016; Rashied, 2018; Bayaga & Morar, 2023). Similarly, Bruinsma (2011) argues that technology has great potential to provide all learners access to the general education curriculum. The notion expressed is that ATs have the potential to be adjusted to the learning needs of students depending on their capabilities, and lecturers or support staff can use the outcomes to provide more appropriate support for each student (Bayaga & Morar, 2023; Watters, 2005). According to Bruinsma (2011), ATs are technical aids or assistive equipment such as:

- Emerging and Innovative Technologies
- Information and Communication Technologies (ICTs)
- Universally Designed Technologies
- Educational Technologies

This implies that an AT can be any tool, equipment, or product system that can be used to aid and sustain students with disabilities' functional abilities to improve educational quality. (Mankoff *et al.*, 2010). Students with disabilities can use Assistive Technology devices independently or with assistance, in and out of the learning setup, depending on their use and implementation, ranging from a simple magnifying glass to a sophisticated computerised communication system (Hersh & Johnson, 2008). These technologies include written language, reading, mathematics, listening, and organisational assistive technologies. All these ATs are designed for inclusive education.

Approaches to Assistive Technology in inclusive education focus on using technology to train, rehearse, assist, and enable learning (Bayaga & Morar, 2023; McGraw-Hill Education, 2016; Watters, 2005). A large population of at-risk students needs assistance. Still, they often do not easily fit into a diagnostic profile and lack services that ATs could provide. The use of ATs can help to educate students with physical, mental, and developmental disabilities in the same classroom and facilitate their understanding of the material as they are capable of removing obstacles that had previously kept them from being on the same level as their peers. (Technology, 2010). With the proper use of adaptive assistive tools, students with disabilities can access more resources and opportunities than ever (Tsatsou, 2020). Correct integration of AATs in inclusive education is expected to alter students' lives because of their impact on freedom, accessibility, and quality of life (WHO, 2023). The improved accessibility afforded by adaptive assistive devices is a significant advantage. Screen readers, speech recognition software, and switch-controlled devices are some assistive technologies that have opened up information access to people who previously could not use them. Access to mainstream educational, occupational, and recreational possibilities is one way that adaptive assistive technologies have helped people with disabilities become more fully participating members of society. (Cao, 2019).

Furthermore, AATs continue to play an essential part in facilitating autonomy for people with disabilities. Wheelchairs and other mobility devices, for instance, allow users greater independence in daily life, including the ability to buy, travel, and engage in social activities. Their mobility, emotional health, and sense of pride have all benefited from this newfound freedom. (Access, 2016). Besides education, the healthcare field has benefited immensely from using adaptive assistive devices to provide quality services to patients. Wearable medical technology, such as insulin pumps and prosthetic appendages, has greatly enhanced the lives of people with long-term conditions or physical impairments. The constant monitoring and management of their conditions also contribute to better health results. (Montaño, 1992).

The developments in ICTs, such as video conferencing and sign language translation software, have made it easier for people who are deaf and hard of hearing to communicate with their loved ones, peers, and coworkers who can listen.. Literature shows that ATs or AATs make it possible for students with disabilities to make meaningful contributions to their academic work, follow their passions and interests, and eventually join the workforce and contribute to their nations' economies. (Cao, 2019). This shows that ATs have the potential to contribute enormously to the well-being and independence of students living with a disability during their university time and after studying. Accessibility, freedom, better health outcomes, and accessible communication make these technologies impact the lives of students living with disabilities (Bayaga & Morar, 2023; Reicher, 2010). The cost of ATs can be a preventive factor for those individuals who want to purchase them for personal use at home, but the provisions of these technologies, in the long run, can outweigh the initial investment. However, the advancement and development of these technologies are expected to continue to improve the lives of people with disabilities to achieve their goals independently, as the advantages far exceed the costs.

Existing literature attests that inclusive education in higher education can be significantly improved by integrating adaptive assistive tools (Bayaga & Morar, 2023; Benson, 2020; Rashied, 2018). The primary purpose of integrating ATs in inclusive education is to level the learning environment to allow students with disabilities to access knowledge and participate in academic activities on par with their non-disabled peers (Shields, 2018). Research consistently demonstrates the advantages of adaptive assistive tools in fostering inclusive education (Shields, 2023; Edyburn, 2020; Kumar & Sinha, 2021; Alquraini, 2012) these tools offer several key advantages, including:

- **Increasing Accessibility** Adaptive assistive tools can significantly enhance the accessibility of information for students with visual, hearing, and motor impairments, allowing them to participate in learning activities alongside their peers at the same pace.
- **Enhanced Communication:** These tools can help students with disabilities communicate more effectively with their classmates and teachers. For instance, speech-to-text software facilitates interaction between pupils with and without hearing loss in the classroom.
- **Personalised Learning:** Adaptive assistive technologies enable individualised instruction for students with disabilities. This may involve using specific software or hardware designed to meet their unique learning needs.

- Fostering Independence Adaptive assistive tools promote independence among students with disabilities. For example, visually impaired students benefit from technologies such as screen readers and magnifiers, which allow them to access information and complete assignments independently
- Improved Physical Access Tools like wheelchair ramps and adapted desks improve access for students with walking challenges, enhancing their ability to navigate the classroom's physical environment.

According to Francisco *et al.* (2020), AATs have the potential to significantly improve inclusive education by giving students with disabilities the same learning and participation chances as their typically developing peers. Schools can improve their ability to serve their pupils by utilising these technologies. The use of Assistive Technology in schools is now essential for students with disabilities because of the difficulties they encounter in the classroom; students with disabilities often fall behind their non-disabled classmates academically. (Technology, 2010).

Viner, Singh, and Shaughnessy (2020) define "Assistive Technology" as the umbrella word for many types of ATs and devices. These aids allow students with physical disabilities to participate in learning activities, communicate with others, and move around campus independently. For example, text-to-speech software assists visually impaired students in reading written learning content displayed on a computer screen. Students with trouble expressing themselves verbally can benefit significantly from augmentative and alternative communication tools. Students with mobility impairments can get around the campus and participate in extracurricular events using powered wheelchairs (Cullen *et al.*, 2012). In this way, ATs help students with impairments to succeed by removing barriers to learning (WHO, 2023; Erdem, 2017). The ATs allow such students to achieve at the same level as their counterparts because they have access to the same resources that enable them to learn new abilities and reach their full potential with helpful technology (Hunt, 2021).

One of the most significant merits of Assistive Technology is its increased autonomy for pupils with impairments. They gain self-assurance and a better sense of themselves due to taking charge of their schooling and achieving success despite challenges. As a result, they are more open to engaging with their classmates and participating in classroom events (Batra *et al.*, 2022). Furthermore, accessible technology aids in fostering inclusion in the classroom by facilitating communication and teamwork. Access to the same technology as their peers can help students with impairments feel more included in the classroom. It promotes tolerance and acceptance among pupils of varying skill levels (Soetan *et al.*, 2020).

Finally, if we want all students to benefit equally from school, we need to invest in helpful technology. It helps students with disabilities gain the freedom and self-assurance they need to succeed in school, and it removes obstacles to group work and classroom participation. More and more people are using Assistive Technology, which means more and more students with disabilities can reach their potential and make good contributions to society (McNicholl *et al.*, 2021).

Many assistive and adaptive technologies are in use today. Table 2.1 shows a sample of different applications of Assistive Technology :

Table 2. 1 Application of Assistive Technology

ARE OF FUNCTION	ASSISTIVE TECHNOLOGY APPLICATIONS	USE
<i>Computer access</i>	<i>Word prediction, alternative keyboard, pointing options, switches, and voice recognition</i>	<i>Students who find it difficult to access the computer in its usual form utilise these gadgets — difficulties performing academic tasks.</i>
<i>Visually Impaired</i>	<ul style="list-style-type: none"> • <i>Screen reader</i> • <i>Text-to-speech</i> • <i>Screen magnifiers</i> • <i>Video magnifiers</i> • <i>Accessible Identification Systems</i> • <i>Color identification</i> 	<p><i>This is for students who have difficulty seeing or lack complete vision.</i></p> <ul style="list-style-type: none"> • <i>JAWS</i> • <i>Window eyes</i> • <i>Zoom text</i> • <i>OrCam MyEye 2</i> • <i>Sunu band, Ruby XL</i>
<i>Writing</i>	<i>Pencil templates, processors book software</i>	<i>For students having a problem with writing or composition</i>
<i>Hearing, Voice, Speech, or Language Disorders Impaired</i>	<p><i>Assistive Listening Systems</i></p> <ul style="list-style-type: none"> • <i>Augmentative and alternative communication devices</i> • <i>Alerting devices</i> 	<p><i>For students who have difficulty hearing.</i></p> <p><i>AVA software</i></p> <ul style="list-style-type: none"> • <i>The MegaBee</i> • <i>Roloquo2Go</i> • <i>GoTalk Express 32</i>

Adopted from Peraković *et al.*, n.d.

2.4.1 Why Assistive Technology for Inclusive Education

Ideally, the presence of adaptive assistive tools in disability units in several South African universities should make it easier for students living with disabilities to have access to resources and opportunities than ever before. However, this is yet to be achieved due to current challenges. One would expect the lives of many students with disabilities to have changed in these institutions due to the impact of these innovations on freedom, accessibility, and quality of life (Scott & Aquino, 2020). Studies conducted worldwide promise a bright future in using AATs in higher education. Authors who have attempted to implement ATs in the South African context have found the technologies promising, though on a small scale. For example, Rashied (2018) used McGraw Hill Connect in a commerce class with average students living with disabilities to aid adaptive learning. The author reports more positive effects of AATs on students living with disabilities as they were able to use the tool in the best way they wanted to learn the concepts being taught. This improved accessibility afforded by adaptive assistive devices in the cited example is a major advantage. A few examples of adaptive assistive technologies that have made information more accessible to most individuals who were previously unable to access it are screen readers, speech recognition software, and switch-controlled devices (Soetan *et al.*, 2020). With the advent of AATs, access to mainstream educational, occupational, and recreational possibilities is becoming a reality if these technologies are integrated constructively into inclusive education to cater to students living with disabilities so that they fully participate in academic societies (WHO 2021).

Additionally, adaptive assistive technologies have facilitated autonomy for people with disabilities. Wheelchairs and other mobility devices, for instance, allow their users greater independence in daily life, including the ability to buy, travel, and engage in social activities. Their mobility, emotional health, and sense of pride have all benefited from this newfound freedom (Trafford *et al.*, 2021). The healthcare field has also significantly benefited from developing adaptive assistive devices. Wearable medical technology, such as insulin pumps and prosthetic appendages, has greatly enhanced the lives of people with long-term conditions or physical impairments. The constant monitoring and management of their conditions also contribute to better health results (Id *et al.*, 2009).

Inclusive education for students with disabilities can be significantly improved with the help of adaptive assistive tools. These tools aim to level the playing field by allowing people with disabilities to access knowledge and take part in activities on par with their non-disabled peers (Alquraini, 2012).

Current literature provides substantial evidence of situations in which adaptive assistive technologies have been successfully and appropriately used to improve inclusive education

by affording students living with disabilities equal opportunities to participate in learning activities to typical peers (Adaka *et al.*, 2022). This implies that the university can provide ATs to meet the learning needs of students living with a disability if proper structures and policies are implemented.

2.4.2 Challenges of Integrating Assistive Technology in Inclusive Education

While so many privileges of integrating ATs in inclusive education have been put forward, the potential challenges to these technologies exist and need some attention in this study. Literature shows the existence of multiple obstacles to integrating ATs into inclusive education. Some are inherent in the technology itself, and others are concerned with pedagogy, management of devices, implementation strategies, and unrealistic expectations (Bayaga & Morar, 2023; Rashied, 2018; Watters, 2005). For example, Hezart, A., Naik, S., Araujo, A., & Watters, P. A. (2005) is of the view that producers of ATs exaggerate their capabilities, and this raises expectations among potential users. This implies a mismatch between what producers claim an AT is capable of doing and the actual performance realised. Another criticism emanates from the inability of ATs to correct misconceptions held by users who think that merely by using these technologies, things happen effortlessly (Rashied, 2018). Issues raised further relate to the algorithm used in educational technologies that are suspected not to adapt to each learner's individual learning needs and seriously limit the intelligibility of the tools (Waters, 2023). According to Mishra, Sharma, and Tripathi (2010), reading, listening, mathematics, writing, and memory or organisational deficits in students with learning disabilities may delay the use and application of ATs at school.

a) Social and technological Challenges Limiting Integration

The following challenges have been identified as limiting the integration of ATs in inclusive education in developing countries (Hamidi *et al.*, 2023).

- Insufficient specialised ICT teachers for children with learning disabilities
- Limited flexibility in training options for children with learning disabilities
- Scarcity of disability-friendly hardware and software resources in developing countries
- Lack of formal involvement from government organisations and support structures for ICT for individuals with learning disabilities
- Attitudinal barriers towards children with disabilities
- Inadequate legislation and policies for disability and their implementation
- Financial constraints preventing institutions from acquiring ATs

Disabled students encounter complex social and technological challenges to their education (Lopez-Gavira et al., 2021). Here are a few examples of such difficulties:

- Challenges in obtaining appropriate technology. Some students with disabilities may have difficulty obtaining the necessary technology to participate entirely in classroom activities. Access to information and the completion of tasks may be hindered without the use of appropriate software, hardware, or assistive technologies.
- Many students with disabilities have trouble getting to their desks, computers, and other classroom tools because of the lack of physical accessibility. Adaptations to the actual space or new ways of obtaining data may be necessary.
- Negative attitudes from classmates or teachers toward students with disabilities can limit their ability to participate fully in class. These mindsets can also cause people to withdraw from society.
- Some students with disabilities may have trouble communicating with their classmates and instructors because of language barriers. For this reason, they may need to use alternative forms of communication or Assistive Technology to take part in all aspects of school life.
- The availability of accessible formats, such as Braille, audio, or large print, for learning resources, can be a barrier for students with disabilities. This may make it difficult for them to finish projects on time or participate in class talks.
- The requirements of students with disabilities may go unmet because their teachers and peers do not understand them or make the necessary accommodations. This may make matters even more difficult for pupils with special needs.
- Some students with disabilities may be unable to afford the necessary resources and accommodations, which can negatively influence their academic achievement

These social and technological challenges can be overcome through a concerted effort by providing accessible learning materials, appropriate technology, modification of physical spaces, training and awareness-raising for teachers and peers, and financial support.

2.4.3. Choosing of Suitable Devices for The Students

The integration of ATs in inclusive education can take many dimensions, namely at the institutional level, departmental, subject, disability unit, and individual levels. Issues always cascade across all levels; hence, there is a need to assist students in dealing with integration issues at particular levels. This implies that students need to be assisted in choosing which technology to integrate for academic and personal use. There is evidence from the existing literature that assistance can be rendered to students with disabilities to find the appropriate

ATs among the many that exist every time a new AT is introduced or the existing ones are upgraded to generate novel options for accommodating students with learning disabilities and differentiating teaching. So far, there is no consensus on or guideline for selecting the best assistive technologies for children with learning disabilities, despite the wide availability of these tools in stores and online (Fernández-López *et al.*, 2013). While there may be no proper guidelines on how students should choose and integrate ATs into their learning, disability units need to have strategies, policies, or frameworks to guide this process. There is compelling evidence that acquiring the best ATs available may translate to their effective use as students living with disabilities continue being marginalised as before the acquisition of the technologies.

The most appropriate way to use an AT, whether bought or made by the student, should depend on the individual's skills, the setting, and the tasks the student wants to complete (Visagiei *et al.*, 2020). This suggests that a given device, service, or platform has the potential to work differently for individual students, depending on how they use it (Svensson *et al.*, 2021; Rashied, 2018). Although there is a variety of ATs to choose from, literature shows that most ATs in higher education institutions where inclusive education is claimed to be offered remain unused for several reasons (Nierling & Maia, 2020). One reason is that ATs are viewed as impersonal and, therefore, influence learning, labour, and This notion is partly due to the manufacturer's or marketers' over-misrepresentation of ATs. (Hezart, Naik, Araujo, & Watters, 2005) strongly believes that the algorithm used in ATs and other educational technologies does not adapt to meet learners' individual learning needs but emulates robotic tutors by simply allowing students to continue to different levels of similar narrow multiple-choice items. Another reason for this poor uptake of ATs is their inappropriate layout (Nierling & Maia, 2020). To assist students with learning disabilities in integrating the ATs on offer in disability units, Raskind (2000) recommends that lecturers and support staff need to identify the precise issues an individual student has. This enabled the choice of the most appropriate AT to match the learning needs of students and educational goals. For students facing challenges with spelling and syntax or having trouble remembering things, specific ATs can be tailored to those individual needs (Svensson *et al.*, 2021). Another suggestion is to establish what each student with disabilities does well (Raskind, 2000). According to Vice (2021), ATs can unlock students with learning disabilities' full potential for learning new concepts and acquiring essential skills needed to solve workplace problems after school. A child with trouble reading printed words but who understands spoken words rapidly may profit from an optical character recognition (OCR) or speech synthesis system that converts written text into synthetic speech. The list of what supporting staff and those providing inclusive education should consider is inexhaustible (Visagie *et al.*, 2020).

a) Best Practices in ATs Choosing

A study by Viner, Singh, and Shaughnessy (2020) elucidates a few best practices on how to choose ATs, namely:

- Have the student assist in making the final decision. This implies that when students are empowered to make decisions, they choose helpful technology devices, services, or platforms they are interested in. In this way, the student can acquire the knowledge and skills necessary to implement reform in the classroom. Therefore, this should be considered when choosing and purchasing tools and when parents or educators foster an interest in technology among children.
- Identify the student's areas of strength and weakness to determine which forms of ATs are most beneficial for a particular learning task. This is done with the understanding that students cannot prioritise purchasing and implementing technologies that do not address their specific requirements and problems. There is a variety of forms and functions found in ATs, which are remarkable, but the student may not be able to select the best when overwhelmed.
- Apply the technology to the exact specifications of the learning goal. The notion is that a student's access to technology can occur in various settings, such as at home, in the classroom, in the playground, in the open field, or with peers.
- Picking compatible technologies is essential to avoid the problem of annoying the student when issues are challenging to solve surface shortly, leading to the AT being unusable.
- Selecting simple and user-friendly technologies is essential for students with learning disabilities who struggle with memory and other cognitive issues. Devices that require the student to be manipulated are inappropriate for such students as they discourage them from integrating the devices into the learning situations.

2.4.4 Measuring the effectiveness of assistive technologies

The effectiveness and applicability of ATs are assessed by their practical use, the ease of their users' usability, and their satisfaction with their environment during environment interaction. Disability unit support staff should be aware that assistive devices are need-based, inexpensive to manufacture, buy, and maintain, easy to use, and effective, and that they can be provided at each point of design and development by the direct involvement of potential users.

When selecting the appropriate assistive technologies (ATs) for students, numerous elements must be carefully evaluated to guarantee that the chosen technologies properly fulfil the students' needs and support their learning and development. These variables include:

a) User Suitability and Climate

The devices should be consistent with the users' aspirations, emotional needs, and ways of living, as well as their culture and local customs, hidden from users' viewpoint by local norms, and physically comfortable. In several cases, it can ensure user protection and be helpful and valuable (McNary *et al.*, 2014), sustainable, secure, and reliable, especially in rural areas, remote areas, and rough environments, consistent with the surface and other conditions of the user's physical environment.

b) Not expensive and Easy to Purchase

The equipment should have a low selling price. In supplying and purchasing devices, the government and NGOs can also aid free of charge or at subsidised rates. The machines should be simple and inexpensive to assemble, manufacture, and maintain. Minimum resources are needed to keep the devices in working order, and they can be repaired using locally available materials and techniques.

c) Easy-to-Use

For users with minimal exposure to technology, technology should be compact (easy to travel from one location to another) and easy to use without extended training or complex skills. They should be able to understand the devices quickly. Assistive provisions in education can allow students with disabilities to learn, depending on the learners' differential abilities and the background and viability of the method. These students can learn at the same level as their non-disabled peers in inclusive educational environments through a collaborative initiative to use assistive equipment, Assistive Technology, resource room support, and creative educational strategies to encourage and sustain inclusion (Provisions *et al.*, 2014)

2.4.5. List Of assistive devices

Table 2.2 shows different types of assistive devices found in disability units of universities that have adopted inclusive education for the entire institution.

Table 2. 2 Different types of assistive devices

<p>a) Smart reader</p> <p>The Smart Reader HD is a portable, lightweight reader/scanner featuring large, easy-to-use tactile control buttons. The Smart Reader HD is a fully integrated system that includes an HD camera and OCR.</p>	
<p>b) Sensory PBRW</p> <p>The Sensory PBRW features the playback of digital talking books or textbooks and the ability to record lectures at school, university, or meetings. You can connect the PBRW to a wi-fi network or hotspot.</p>	
<p>c) Transformer HD</p> <p>Transformer HD is a high-performance portable electronic magnifier used for reading printed documents and viewing distance information, such as the whiteboard in a classroom.</p>	
<p>d) Snow 7 HD Plus</p> <p>Zoomax Snow 7 HD Plus is the first 7" handheld video magnifier in the global market to adopt text-to-speech technology. Offering storage for up to 1,000 images and superb distance viewing, Snow 7 HD Plus is a new entry for low-vision people to regain independence.</p>	
<p>e) BrailleSense Polaris</p> <p>The Braille Sense Polaris Mini offers a new standard in blind-friendly applications with the latest cutting-edge technology. BrailleSense Polaris MINI supports Google Apps, making it easy to utilise Google services like Drive, Docs, Sheets, and Slides.</p>	

2.5 SOCIO-TECHNICAL CHALLENGES FACED BY STUDENTS WITH DISABILITIES

One of the problems faced by students with disabilities in higher education is the shortage of ATs for Inclusive Education that connects them with their classroom instructors, disability unit staff, and CHETL support structure for their academic support.

Regardless of socioeconomic standing or differences in power or disability, education is still the most critical element in one's development, empowerment, and equality (Ahmad, 2014).

Common challenges to inclusive education include financial and governmental support, poorly drafted policies and regulations, unqualified teaching staff, and a weakened economy. A significant barrier to inclusion is the inefficient and unsustainable use of Assistive Technology . People who have disabilities are often trapped in a cycle of isolation from mainstream educational, cultural, and development programs due to a lack of accessible tools and equitable participation opportunities.

Technology is a big part of how our society and the world change so quickly. It is unavoidable that it has improved people's lives in significant ways. The presence of technology influences the development of numerous innovations. It opens up new possibilities for a population with high expectations. The educational system has had to adapt to the new realities of technological advancements. The Philippines' school system recognises the value of technology in the classroom (Arinto., 2016). Technology integration is a valuable tool for achieving the aims of teaching 21st-century skills and becoming globally competitive. Its existence in a school containing students with special needs is crucial to the success of those students (Facer, 2011).

When students with special needs are integrated into general education settings, educators must also identify and remove any barriers that prevent their full participation in the learning process. According to Cogburn and Levinson (2008), alluded that by creating a Least Restrictive Environment (LRE) for students with disabilities, we can guarantee that they will be able to learn in a manner that is acceptable to them and the rest of the class.

Medical interpretations of disability have come a long way from viewing impairments as personal deficiencies to the modern concept of human rights and equitable opportunity for all people. (Swart & Greyling, 2011).The social model of disability says that the primary barriers that hinder people with disabilities are social exclusion, structural barriers, and negative attitudes. This clarifies how a person's functional state, physical traits, and social and political environments affect each other. This is the root cause of impairment (Cogburn & Levinson, 2008). Let us suppose that everyone has all they need to survive and prosper. People with disabilities may then actively engage in society, despite their limitations. As a result,

addressing disability effectively requires action on both individual and societal levels. This involves not only medical rehabilitation but also the provision of essential support services, the implementation of universal design to enhance infrastructure accessibility, a shift in attitudes and perceptions toward disabilities, the promotion of inclusive education systems, and community awareness campaigns to combat stigma, among other initiatives (Patrick & McKinnon, 2022).

There is a substantial unmet need for AT, with more than 90% of people who could profit from it but do not have access. UNICEF (2014) reports that only 5–15% of persons living with disabilities worldwide have met their needs with ATs. Children in regular and special education settings may have different disabilities (Ahmad, 2014). It is understood and accepted that children with disabilities encounter unique classroom difficulties that must be considered to succeed in their academic pursuits. This shifts the focus from the children to the environmental variables that affect them and may even encourage their participation in everyday life (McNeill *et al.*, 2016).

"Functioning" and "impairment" are multi-dimensional concepts related to specific bodily functions and systems. They encompass the actions of individuals, the domains in which they participate, and the environmental factors that influence these interactions. In contrast to the intricate functioning of the human body, activities can be defined as intentional movements undertaken by individuals to accomplish specific objectives. Lutfiyya and Bartlett (2020) define involvement as active participation in activities necessary for an individual's economic and social well-being. These activities encompass various social roles that contribute to one's overall existence, such as the ability to access education. The impact of disability on an individual's ability to engage in activities or participate in society is not necessarily determined by the extent of impairment in bodily functions. Instead, it depends on how much the environment can adapt to the person's varying functional capabilities (Banbury *et al.*, 2008). Therefore, institutions of higher learning seek to provide such an environment by having disability units with staff specialised in inclusive education.

2.6 SUMMARY

The literature review in this chapter highlights a significant gap in integrating Assistive Technology within historically disadvantaged institutions. Challenges such as inadequate funding and the lack of supportive policies or frameworks hinder the effective use of Assistive Technology in these settings. Insufficient financial resources limit the acquisition and maintenance of Assistive Technology tools, while the absence of clear institutional guidelines impedes their adoption and utilization. Addressing this gap requires collaborative efforts to

secure funding, develop inclusive policies, and promote awareness, ultimately creating more accessible and supportive learning environments for all students.

CHAPTER 3: THEORETICAL FRAMEWORK

3.1. INTRODUCTION

The foregone chapter presented a detailed literature review on pertinent issues concerning AT integration in inclusive education. The literature shows that AAT integration in inclusive education can make education accessible to students living with disabilities, making them independent learners capable of participating freely in socio-economic activities. Furthermore, challenges exist to integrating ATs in inclusive education due to implementation problems due to multiple factors, including the lack of proper integration strategies. To further understand key issues hindering the integration of ATs in inclusive education in higher education, it has been important to analyse existing frameworks used critically. A better understanding of the existing frameworks and best practices can guide in deciding the theoretical framework for the study.

3.2. THEORETICAL PERSPECTIVES IN INFORMATION SYSTEMS RESEARCH

Models have always been considered essential elements of research designs in IS because they can be used as links between theories and data and assist on-making when selecting data collection and analysis methods (Payne, Pearson & Carr, 2017). One of the key concepts in IS research is system use (Fidock & Carroll, 2009). In many cases, researchers seek to understand and predict the use of an IS to justify its investment benefits. According to Fidock and Carroll (2009), an underutilised, misused or avoided system does not achieve the wishes of designers or investors. This applies to the ATs in disability units in universities, which may remain unused because of inherent problems that, when not solved, are associated with disabilities. Because of the importance of integrating ATs, it became important to critically evaluate system thinking theories based on the variance and process perspective to identify those that can be used in this study.

The most discussed models used in IS research are associated with the variance, process, and systems perspectives, primarily distinguished by their major epistemological approaches and paradigms (Burton-Jones, McLean & Monod, 2018; Povic, 2021). These models examine the system use. Clarke and Davison (2016) define a researcher's viewpoint as that of a certain stakeholder in the relevant domain, which the researcher uses to observe events while conducting a research study. This definition is corroborated by Burton-Jones, McLean, and Monod (2016), who posit that a perspective is a researcher's choice of the concepts and relationships used to construct a theory. In IS research, the researcher can choose a perspective from variance, process, or systems model depending on the problem being

addressed. Figure 3.1 and Table 3.1 illustrate each of the three models from which such choices can be made.

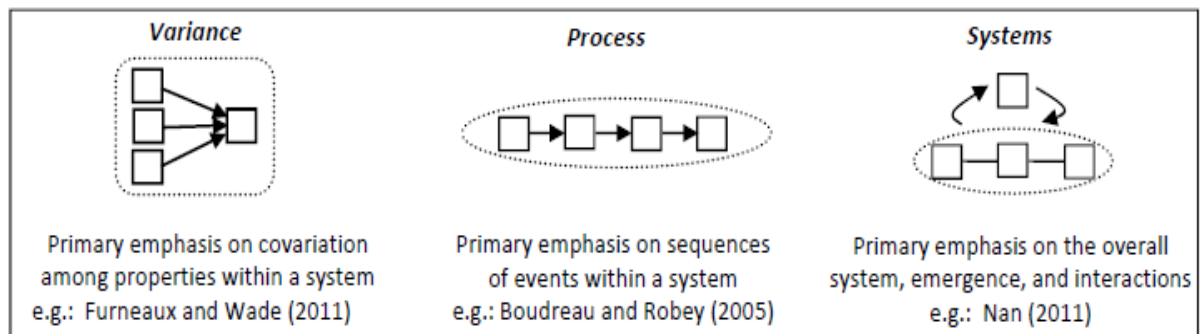


Figure 3. 1: Relative emphases of the variance, process, and system perspectives

Source: Burton-Jones, McLean & Monod (2018)

Table 3. 1: Common differences among the variance, process, and system perspectives

Dimension	Variance perspective	Process perspective	Systems perspective
1. Type of concepts	Properties of entities that have varying values	Entities that participate in or are affected by events	Systems/wholes (comprising parts) that have emergent properties
2. Change in concepts over time	Properties do not change over time (only their values change)	Entities change over time	Systems/wholes, their parts, and their properties can change over time.
3. Types of relationships	Variation among values of properties	Sequences among events (typically probabilistic)	Interactions among parts and reciprocal relationships
4. Time ordering in the relationships among concepts	Time ordering among independent variables (properties) is not important	Time ordering of events is important	Time ordering of events and properties is important

Source: Burton-Jones, McLean & Monod (2018)

Of the three perspectives, variance and process are the two most used (Payne, Pearson & Carr, 2017) and are discussed to illustrate how this research study fits into either. Each of these two models represents a different perspective regarding research questions being addressed in a study or a particular phenomenon being researched (Payne, Pearson & Carr, 2017). The process models are used to understand events and narratives to address the question, “How does the issue or phenomenon change over time?” while the variance models are used to examine the relationships between independent and dependent variables to address the questions being asked, “What are the backgrounds, experiences, precursors, and consequences associated with the issue or phenomenon” (Payne, Pearson & Carr, 2017). Table 3.2 illustrates the main differences between process and variance models

Table 3. 2: Basic differences between process and variance models

Comparison point	Process model	Variance model
Research question	How does an issue emerge or change over time?	What are the antecedents and consequences of an issue?
Epistemology	Event-driven and narrative	Outcome-driven and logico-scientific
Basic purpose	Explain a sequence of events based on a narrative or story	Explain changes in dependent variables in terms of causal independent variables
Unit of analysis	Events within which entities (i.e., individuals or collectives) participate; entities may change because of events	Entities (i.e., individuals or collectives) that possess specific variable attributes
Temporality	Critical for understanding linkages between events and patterns	Largely immaterial among independent variables
Causality	Can involve both immediate and more distal causation; explanations can be complex and layered in different time scales.	Emphasises immediate causation, which is indicated by covariation, temporal precedence, and no spurious factors
Epistemology	Event-driven and narrative	Outcome-driven and logico-scientific
Basic purpose	Explain a sequence of events based on a narrative or story	Explain changes in dependent variables in terms of causal independent variables

Adapted from Payne, Pearson, and Carr (2017)

3.2.1 Variance theories

Researchers use variance-based research to investigate the connection between variables by methodically conducting experiments or studies to comprehend how shifts in one variable can lead to changes in another (DeLone & McLean, 1992; Scott, n.d; Fidock & Carroll, 2009). This suggests that a large portion of variance research is based on quantitative, survey-based techniques (Burton-Jones & Straub 2006), in which measures are carefully designed to guarantee their validity and reliability. This provides an unbiased basis for concluding the degree to which related variables manifest (Lee, 1999). Information Systems research utilising the variance theory adopts a perspective that emphasises use as a thing that changes in value but not identity or character (Fidock & Carroll, 2009). Use is mainly understood in terms of its extent, with limited exploration or definition of the concept (Burton-Jones & Straub, 2006). According to Van de Ven and Poole (2002), variance research is more suitable for answering "what" questions, which try to predict the extent to which a system is used. In this study, the variance approach was used to investigate factors influencing the integration of ATs from the quantitative data collected through a survey questionnaire. A detailed data collection process was provided in Chapter 4 under the banner research techniques.

3.2.2 Process theories

Process models have historically been employed to construct sequences of events or stages to arrive at a specific outcome (Mohr, 1982; Guy Paré *et al.*, 2008), elucidating how and why a process evolves in a particular way to accomplish specific outcomes (Langley, 1999; Okoli, 2022). In contrast, process research often offers qualitative descriptions and analyses that capture the evolving nature of the phenomena under study (Van de Ven & Poole, 2005; Wolfe, 1994). According to Okoli (2022), process theories have merits over variance theories because they readily map to people's intuitive way of thinking about phenomena that match human experience, and they are strongly causal, making them suitable for practical use in research. This has previously been indicated by Mohr (1982), who believes that the variance perspective was not ideal for studying organisational change but the process perspective. A study by Paré, Bourdeau, Marsan, Nach, and Shuraida (2008) found that only 20% of articles in popular IS journals utilised the process perspective. Van de Ven (1992) examines a process from three angles, namely: i) a sequence of occurrences that depict development over time, ii) a class of ideas or variables about acts conducted by people or organisations, and iii) a logic that clarifies a causal relationship between variables, regardless of whether they are dependent or independent. Process research often offers qualitative explanations and evaluations of how the phenomenon of interest develops (Van de Ven & Poole, 2005; Wolfe, 1994). These explanations involve characterising change as a sequence of stages or something that emergent activities produce continuously. The concept of usage is understood

as developing throughout time, focusing on characterising and elucidating its nature through ideas like technological adaptation and appropriation (Carroll, 2004; Tyre & Orlikowski, 1994).

Process theories have a substantial causal component because they outline the prerequisites that must be satisfied to produce a particular result and regard the relationship between the ideas (events) as generally characterised by the justification for why event B cannot occur in the absence of A or the explanation of how occurrence A would typically lead to event B (Fidock & Carroll, 2009; Okoli, 2022; Payne, Pearson & Carr, 2017). In contrast to variance theories, process theory focuses on the existence of events A and B rather than their nature, worth, or intensity. This means that process theories stipulate that the occurrence of B requires the prior occurrence of A, whether at a high or low degree (Fidock & Carroll, 2009; Okoli, 2022). They do not necessarily suggest that more intense occurrences of A would be more likely to result in the occurrence of B (Okoli, 2022; Payne, Pearson & Carr, 2017). Greater emphasis is placed on defining these use concepts, with Carroll (2004) and Tyre and Orlikowski (1994) offering comprehensive descriptions. Qualitative research approaches are favoured when using the process models because they offer more detailed accounts of the nature and chronology of events being studied (Wolfe, 1994; Meneses & Varajão, 2022).

The process approach is generally used to answer the “how” questions (Van de Ven & Poole, 2002; Meneses & Varajão, 2022). Therefore, this study used the process approach to understand how students with disabilities utilise ATs in the disability unit; these could be improved to aid inclusive education and enhance academic and socio-economic participation. Pressman (1997) argues that factors such as the nature of the project, the kinds of tools and processes to be employed, and the requirement for regular deliveries and controls should all be considered when choosing a process model for the study. The theoretical frameworks of a process perspective study seek to explain the outcome by referring to a sequence of events involving the key stakeholders (Newma & Robey, 1992; Boudreau & Robey, 2005). Process theories are valuable tools for comprehending problems related to developing and executing information systems, evaluating their effects, and foreseeing and controlling the change processes connected to them (Crowston, 2000; Kaplan, 1991). The primary benefit of process theories over variance theories is their ability to handle more intricate causal links and explain the relationship between the inputs and outputs instead of just stating it (Crowston, 2000). This implies that process theories offer a conduit for the interaction of research paradigms and a link between human and organisational phenomena. However, merging process theories with variance theories can enhance the findings of a study.

3.3. USING MODELS BASED ON VARIANCE AND PROCESS PERSPECTIVES

This study seeks to employ variance and process theories to determine and understand factors influencing the integration of ATs in inclusive education and propose a framework to improve the integration. By applying both variance and process research theories, this study is placed in the mixed method design, applying ethnographic or case study designs where the researcher can utilise both qualitative and quantitative methods. The variance was used first to explore the factors influencing the integration of ATs in inclusive education at the institution. The process explored strategies that could be used to support the proposal of a framework for integrating AT in inclusive education. This idea is borrowed from a study conducted by Fidock and Carroll (2009), which blended variance and process approaches to understand system use. There is a plethora of literature encouraging IS researchers to use both the variance and process approaches in IS research, which deals with complex issues such as the use of a system (Sabherwal & Robey, 1995; Van de Ven & Poole, 2005)

Variance theory deals with conceptual constructions that relate variables to one another. In contrast, process theories deal with conceptual constructions that focus on how phenomena emerge, change, or end over time through activities and events (Cloutier & Langley, 2020). When using a process model, the researcher pays particular attention to temporality and change over time, unlike when utilising a variance approach. In order to explain the factors influencing the integration of ATs in inclusive education in higher education at the selected university, the variance model was used to determine the relationships in quantitative variables. The process model requires exploring participants' perceptions, beliefs, and experiences. The process theory examines how students living with disabilities interact with ATs to satisfy their information needs and how they cope with the challenges they face. This implies that these two theories were applied, as Fidock and Carrol (2009) suggested. According to Fidock and Carrol (2009), combining variance and process models can give the researcher a better understanding of the phenomenon being studied than when only one model is used. Markus and Robey (1997) further explain the purpose and distinctions between variation and process theories. These authors assert that variance theories are used to forecast outcome levels from levels of existing predictor variables, as opposed to process theories, which explain how outcomes vary over time.

Another point of contention between variance and process theories is how they define outcomes and precursors. In variance theories, these structures are commonly seen as variables or entities with various values (Markus & Robey, 1997). Process theories view the results as discrete or discontinuous phenomena, also called shifts in state, as opposed to variables with a range of possible values. Process theories are helpful because they recognise

and value the complexity of causal connections while upholding the goals of generalisability and prediction (Jiang, Klein & Means, 2000; Meneses & Varajão, 2022; Vlastic, Yetton & Liu, 2010). Therefore, this study uses both variance and process theories to understand the factors that affect the integration of ATs in inclusive education and then develop a framework for that purpose. Newman and Robey (1992) view research following the process models as being constructed based on episodes and encounters of users and systems analysts. This implies that a study adopting the process approach focuses on the dynamics of social change and tries to explain how and why the results of development efforts are achieved or not (Newman & Robey, 1992).

On the one hand, examples of theoretical frameworks that can be used with variance theories suitable for this study include the Task-Technology Fit (TTF) Theory Grobbelaar and Botha (2020), the Theory of Planned Behaviour, the Technology Adoption Model (TAM) (Rahayu and Day, 2015; Olushola & Abiola, 2017), the Unified Theory of Acceptance and Use of Technology (UTAUT) Model Hamida et al. (2016).. On the other hand, examples of the theoretical frameworks to be adopted for the process perspectives include the DeLone and McLean Information Systems Success Model (DeLone & McLean, 2003; Elazzaoui & Lamari, 2022), the Innovation Resistance Theory (IRT) (Fidock & Carroll, 2009), and Human Activity Assistive Technology (HAAT) (Giesbrecht., 2013) . However, frameworks to understand the level of disability, the forms of learning challenges, and the technologies that can be needed require the study to take cognisance of the International Classification of Living, Disability, and Health framework (ICF), which is neither a variance nor a process theory. Before exuding on the selected process and variance theories, it is essential to have insights into the ICF and its concept of disability.

3.3.1 International Classification of Living, Disability, and Health

To adopt and use technology in inclusive education, it is essential to understand the underlying disabilities that learners have and what the technology seeks to address. The International Classification of Living, Disability, and Health is one of the frameworks used for this purpose because it provides a standard language and a conceptual basis for defining and measuring one's health and disability (Martinuzzi *et al.*, 2010; World Health Organization, 2007). The components of the ICF paradigm and their interplay are shown in Figure 3.2.

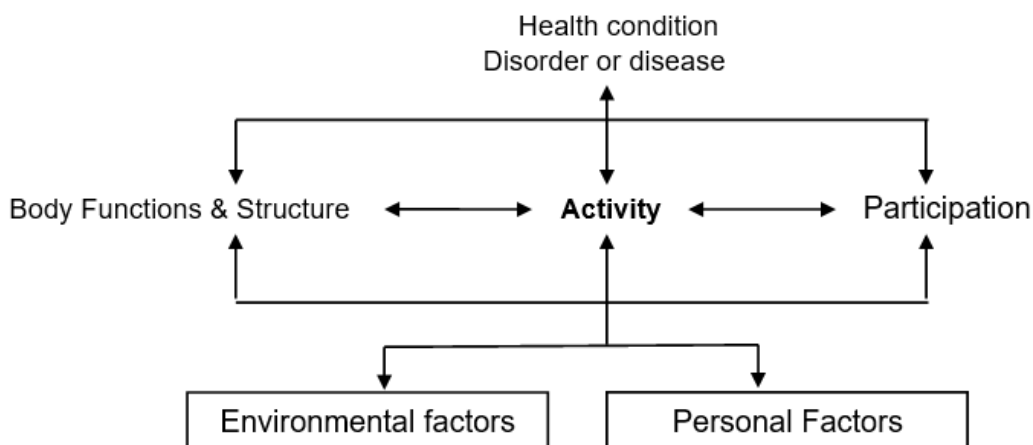


Figure 3. 2: The ICF Model (World Health Organization, 2001)

According to the ICF, impairment is caused by how a person's health and environment work together (Mini, Dianne & Jill, 2006). In this perspective, an unhealthy condition (disorder or illness) is considered the root cause of impairments, activity constraints, and participation restrictions (Cozzi *et al.*, 2021). The ICF emphasises that *functioning and disability* are multi-dimensional concepts based on the following:

- The body functions and structures of people and impairments that restrict individuals from performing simple activities expected of them (Hurst, 2003; Stucki, Reinhardt, Grimby & Melvin, 2007; World Health Organization, 2001). The functioning at the level of the body is inherently essential to consider foremost;
- The activities of people and the activity limitations they experience (Hurst, 2003; Stucki *et al.*, 2007). This deals with the functioning at the level of the individual and how the ability or inability to perform specific tasks can hinder, promote, or impede the development of a person living with a disability;
- The participation of a person in all areas of social life and the restrictions likely to be experienced (Hurst, 2003; Stucki *et al.*, 2007; World Health Organization, 2001). This looks at how an individual functions as a member of society and
- The environmental factors that affect the experiences of individuals living with disabilities (Hurst, 2003; Stucki *et al.*, 2007; World Health Organization, 2001). Environmental factors can promote or hinder the participation of persons with disabilities in social life activities, including education.

Implicitly, the ICF treats the level of the working person as an interaction of one's health conditions and environmental and personal factors. According to Stucki *et al.* (2007), the ICF is a critical framework that can be applied to research and education to assist professionals in viewing disability from a functioning perspective instead of the perspective of a health

condition when providing services. Similarly, Martins, Alexandra, Margarida, Nelson, and António (2012) think that the ICF introduced the paradigm of inclusivity and universality that encouraged individuals with different disabilities to participate with other members of the communities. The ICF framework has been used in several studies to understand the provision of better education for students living with disabilities in different environments. For example, Mitra and Shakespeare (2019) purport that the adoption of the ICF by the World Health Assembly enabled research into the socioeconomic determinants of health conditions, which were partially known by then. Since then, the ICF has been used in various research, including a study by Bratan, Fischer, Maia, and Aschmann (2020) on social and technological obstacles faced by students with disabilities such as blindness and visual impairment, deafness, hearing impairment, as well as autism spectrum disorder (ASD), in Germany, Hungary, Portugal, and Sweden. The studies found several social barriers that influence the integration of people with disabilities into social contexts despite the high use rate and openness to ATs. The study concluded the experiences of individuals with visual, hearing, and autism spectrum disorders in three different social contexts: independent living, education, and the workplace (Maia *et al.*, 2018; Patrick & Mckinnon, 2022; World Health Organization, 2001). The ICF seeks to change the perspective of how care and services are provided to people living with disabilities by empowering them to realise their potential to be independent people who voluntarily participate in education and socio-economic development (Martins *et al.*, 2012). Therefore, the empowerment sought by the ICF is directly related to the motivation of an individual to control their participation by developing the necessary skills needed to adapt and influence the environment (Martins *et al.*, 2012). The application of the ICF in this study is relevant as it can be used to address the integration of ATs to empower students with disabilities in institutions of higher learning.

3.3.2 Variance Theories

Theories can be understood as overarching frameworks or explanations for phenomena, while variances typically refer to differences or discrepancies within a set of data or observation the following are the example:

3.3.2.1 Task-Technology Fit (TTF) Theory

In an organisation, technology is frequently utilised to create value by enhancing or supporting individual and group work. However, it necessitates significant resources for acquiring, deploying, and using various technologies (Spies, Grobbelaar & Botha, 2020). The Task-Technology Fit (TTF) theory (Figure 3.3) is a variance theory used to describe the interplay between three components at a certain point in time: technological functionality, task needs, and individual skills (Goodhue, 1995; Goodhue & Thompson, 1995; Goodhue & Klein, 2000;

Anderson, Nardelli & Ipsen, 2021). According to Spies, Grobbelaar, and Botha (2020), the TTF theory depicts a way to measure how beneficial technology is in a system by evaluating how the technology and the tasks it is intended to assist or relate to each other.

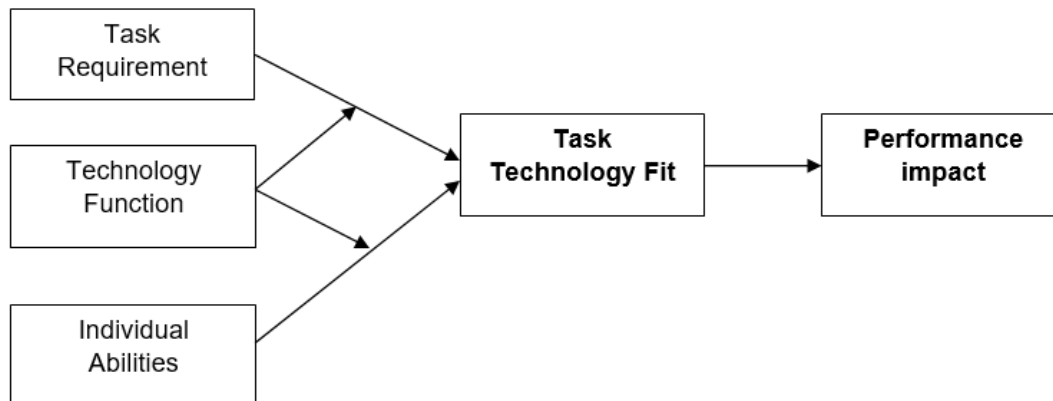


Figure 3. 3: Interacting Elements of the Basic Task-Technology Fit Model

Source: Spies, Grobbelaar and Botha (2020) and Anderson, Nardelli & Ipsen (2021)

The TTF assumes that system users can accurately evaluate the level of TTF while they utilise technology to complete tasks and that the evaluation of TTF may predict performance (Anderson, Nardelli, & Ipsen, 2021). According to Dishaw (1999), TTF is an assessment of user experience based on several factors, including data quality, usability, and technology reliability. When using the TTF theory, the researcher expects users to be able to assess both the functionality of the technology and the extent to which it assists them in completing given tasks and how it matches their skills and knowledge (Dishaw, 1999; Spies, Grobbelaar & Botha, 2020). The proponents of the TTF theory argue that the higher fit between technology, task requirements, and individual abilities always results in better performance, and this ultimately leads to efficient task accomplishment (Goodhue, 1995; Espedido, Searle & Griffin, 2020; Fuglseth & Sorebo, 2014). It is expected that outstanding performance is attained when the TTF is optimal, a situation whereby there is a match between technology and the task characteristics it seeks to aid as well as the individual skills of the users, enabling smooth execution of the activities being done (Spies, Grobbelaar & Botha, 2020; Anderson, Nardelli & Ipsen, 2021).

Task requirements refer to people's physical and cognitive acts to convert inputs into outputs in a particular environment. They may include varying levels of specificity and requirements about the technology being used to assist the user in completing the tasks (Espedido, Searle & Griffin, 2020; Gebauer, Shaw & Gribbins, 2010).

For this study, such technologies often include ATs and support services (training, HR policy, and IT support). Technology functionality is always tied to the context in which it is used and the tasks it aims to complete. This moderating technology component enables individuals to employ technology to execute work to improve performance.

Furthermore, individual abilities indicate the various traits of a person that may influence how they use technology to perform job responsibilities. This component refers to a person's internal resources, such as motivation, experience, and training in various technologies (Goodhue & Thompson, 1995). The TTF component refers to how technology assists users in accomplishing their work tasks. Task needs, technology functionality, and individual ability determine TTF. The performance impacts represent an individual's task accomplishment. Higher performance implies a combination of enhanced efficiency and effectiveness and improved overall output quality (Anderson, Nardelli & Ipsen, 2021). This study used this model to investigate the factors influencing the use of technology for academic purposes by students living with disabilities and the challenges they face.

3.3.2.2 Theory of planned behaviour

One of the most important theories used to forecast people's behavioural intentions when utilising information technology in an organisation or the market is the Theory of Planned Behavior (TPB) (Rahayu and Day, 2015; Olushola & Abiola, 2017) shown in Figure 3.4.

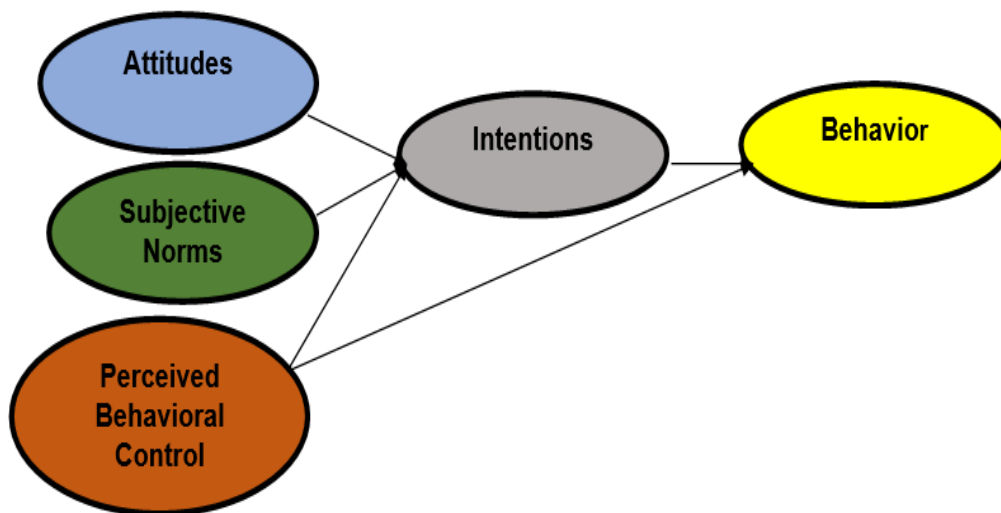


Figure 3. 4: Theory of Planned Behaviour Model

The TPB views an individual's behaviour as mainly influenced by three factors: 1) behavioural intentions, how one feels about the behaviour; 2) subjective norms, about the behaviour's performance; and 3) behavioural control, one's assessment of how simple the behaviour can

be performed (Leong *et al.*, 2022; Ajzen, 1991). Attitude toward the behaviour refers to an individual's positive or negative feelings about engaging in a specific behaviour (Ajzen, 1991; Mary & Amber, 2021). Consequently, adopting and using technology based on the Theory of Planned Behavior (TPB) hinges on an individual's behavioural, normative, and control beliefs regarding the technology's benefits (Ajzen, 1991; Akinbi, 20157). This theory posits that behavioural beliefs can shape an individual's evaluation of the desirability of adopting and using technology (Wisdom, Suite & Horwitz, 2014; Bach, Celjo & Zoroja, 2016). This means that decision-makers in an organisation such as a university or department can adopt and use ATs after evaluating the benefits and risks of the technologies to users and the intended learning outcomes. Ironically, a successful evaluation depends on the decision maker's knowledge of the technology and applications, their work, and the provisions and risks involved (Wisdom, Suite & Horwitz, 2014; Hamida, 2016).

Normative beliefs are perceived social pressures experienced by an individual as a result of competition that may persuade an individual to adopt and use innovations (Fry, Ryley & Thring, 2018). This means that the adopter could be influenced by other users' opinions on the benefits and risks of the ATs. Therefore, normative beliefs can influence one to behave logically or illogically when using technologies to complete a task (Ajzen, 1991; Williams & French, 2014). The TPB considers rational behaviour as an individual closely assessing the merits and demerits of the technology they intend to adopt or use (Ajzen, 1991; Momani & Jamous, 2017). Nevertheless, illogical behaviour can result from social pressures compelling a person to accept and utilise technology that contradicts an organisation's goals (Taherdoost, 2018). This implies that decision-makers in an organisation, department, or disability unit should be careful about the merits and demerits of accepting ATs, whether they benefit students with disabilities, and must refrain from recommending adopting and utilising ATs without proper evaluation.

Finally, behavioural control beliefs suggest how easy or hard it is to use technology to achieve the desired outcome (Williams & French, 2014; Fry, Ryley & Thring, 2018; Taherdoost, 2018). Literature shows that rather than the advantages the new technology can provide to an organisation or individual, its adoption is further influenced by the knowledge and skills that might be required for its effective use (Renny, Guritno & Siringoringo, 2013; Fry, Ryley & Thring, 2018). The implication is that decision-makers in the university, department, or disability units may evaluate how easy-to-use the ATs and applications are but overlook some essentials that students consider to be important when using the ATs (Afolaranmi, Ferrer & Martinez-Lastra, 2018; Afolayan & de la Harpe, 2019). The overall impression is that the TPB suggests individuals decide to choose technology due to their beliefs about the merits or

demerits of the possible results of utilising the technology (Sniehotta, Presseau & Araújo-Soares, 2014; Olushola & Abiola, 2017).

Generally, the TPB urges decision-makers in organisations, departments, or disability units to carefully plan, assess, and evaluate the potential benefits of ATs, usability, and dangers before and after acceptance. In some cases, the staff in the disability units can recommend the adoption of ATs due to pressure from sister departments or universities and ultimately not realise any benefits but to keep up with technological trends to the detriment of students' academic endeavours. Importantly, decision-makers and lecturers in the university may have time limits to learn how to use technology because of other commitments, resulting in some quality of the technology being perceived as challenging to understand and having remote chances of being adopted or appropriately used by students. With the advantages of integrating ATs in inclusive being well-documented, the challenges faced by students and staff in disability unity can be investigated using the TPB.

The TPB has its share of weaknesses due to a lack of guidelines on how individuals can assess the merits and demerits of ATs besides asking from the suppliers, who may also have limited knowledge or act to promote business. The TPB is much more helpful when considering adopting a technology rather than evaluating issues in integrating ATs already acquired by an organisation. Prominent limitations to TPB considered in this study include:

- The assumption that individuals always have opportunities and appropriate resources required to behave desirably despite the intention (Miller, 2017);
- Inability to link motivation and behavioural intention to external stimuli like fear, danger, attitude, or past experiences (Williams & French, 2014);
- Disregarding how the economy and environment may influence people's decisions to use new and existing technology in a particular way (Miller, 2017);
- The assumption that human behaviour is due to a predetermined and easy decision-making process that remains the same over a long time (Miller, 2017);
- The belief that an individual is powerless over their actions (Sniehotta, Presseau & Araújo-Soares, 2014); and
- The inability to foresee the time interval between the intent and behavioural action (Williams & French, 2014).

Despite these shortfalls, the TPB can be used to investigate the lecturers, staff in the disability units, and those tasked with the procurement of the ATs and how they intend to make the disability unit a worthy place for students to be in their quest for better education.

3.3.2.3 Technology Acceptance Model

The TAM illustrated in Figure 3.5, is a prominent technology adoption framework that highlights perceived usefulness (PU) and perceived ease of use (PEOU) as the key factors influencing the adoption of IT applications and devices (Momani & Jamous, 2017; Olushola & Abiola, 2017). The TAM outlines a multi-stage process where external factors, such as system design features, trigger cognitive responses like perceived ease of use and perceived usefulness. These cognitive responses then generate affective responses, such as attitudes toward using the technology or the intention to use it, which ultimately impact actual usage behaviour (Horst et al., 2007; Hamida *et al.*, 2016; Marikyan & Papagiannidis, 2023).

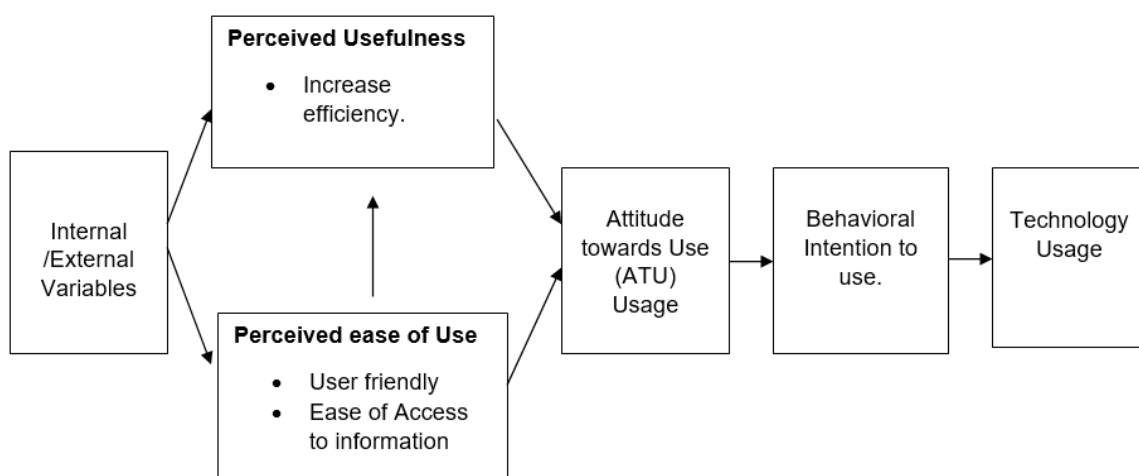


Figure 3. 5: Technology acceptance model

Source: Hamida *et al.* (2016).

The Technology Acceptance Model (TAM) proposes that behaviour can be predicted by perceived ease of use, perceived usefulness, and behavioural intention. Perceived ease of use and perceived usefulness are based on the expectation of positive outcomes and the belief that the behavior is not labor-intensive (Miller, 2017). At the individual user level, TAM suggests that behaviour results from weighing the expected benefits against the effort or costs involved (Marikyan & Papagiannidis, 2023). Adopting a system or device can be anticipated by assessing the trade-off between its usefulness and difficulty (Marikyan & Papagiannidis, 2023). In this context, perceived usefulness refers to the extent to which an individual believes that using a technology enhances performance, while perceived ease of use relates to the degree to which the system is perceived as effortless (Hamida *et al.*, 2016). The TAM suggests that easy-to-use systems perceived as being useful are quickly adopted and continue to be used. The TAM evolved to TAM2 and TAM3, improving the theory using many external factors as variables. TAM and its variants are used in various fields of studies, contexts, and

geographical locations as critical theoretical models for predicting user behaviour in technology adoption and use.

According to the TAM, an individual's or enterprise's intentions to adopt and keep using information technology tools and services are influenced by perceived use and perceived ease-of-use of the technology to explain problems or support a cause (Horst, Kuttschreuter & Gutteling, 2007; Hamida *et al.*, 2016). IT devices and applications are adopted when perceived as valuable and easily used. Many studies used the TAM to explain the acceptance and continuation of the use of IT products (Venkatesh *et al.*, 2018). However, several criticisms against the TAM make it unsuitable for studying how enterprises adopt technology, but it is suitable for accepting and using technology at an individual level (Lai, 2017; Ajibade, 2018). A study by Ajibade (2018) concludes that TAM cannot explain why users adopt and use unpopular technologies such as e-government while ignoring popular ones. TAM is also criticised for its inconsistency in explaining users' behaviours when buying, accepting, and rejecting a new technology (Hai & Alam-Kazmi, 2015). Furthermore, TAM is criticised for ignoring the assessment of dangers as it emphasises the merits and helpfulness of technology (Horst, Kuttschreuter & Gutteling, 2007; Hamida *et al.*, 2016). The inability to use TAM to assess PU and PEOU practically is another criticism by Wu (2012). Literature shows that TAM tends to focus much on the individual user of technology while ignoring the critical social processes of IS development and implementation, does not assess where more technology is practically better and is silent about the social consequences of IS use (Fathema, Shannon & Ross, 2015; Lee, Kozar & Larsen, 2003). Furthermore, TAM is conceived as a framework of perceived usefulness and ease of use, which overlooks some other vital issues, including cost and structural imperatives that can compel individual users to adopt the technology (Lunceford, 2009; Pikkarainen, Pikkarainen & Karjaluoto, 2004).

The TAM has been extensively used primarily to investigate technology adoption and use within workplace applications (Venkatesh & Bala, 2008; Venkatesh, Morris, Davis & Davis, 2003), making it suitable for this study. This is confirmed by Marikyan & Papagiannidis (2023), who suggest that TAM is a good model for the individual user of IT devices and applications, which can be easily extended to the organisational level. Despite its weakness, the TAM can be used to investigate the acceptance of ATs by students, lecturers, and decision-makers in the disability units of the university.

TPB and TAM are examples of variance theories used to determine how one variable depends on the other. These can be used for hypothesis testing, particularly on how the PU and PEOU of technology for students, decision-makers, and lecturers affect their continued use of technology to support inclusive education.

3.3.2.4 The Unified Theory of Acceptance and Use of Technology (UTAUT)

The UTAUT model Figure 3.6 is a comprehensive framework that integrates and extends eight popular theories to explain the acceptance and use of technology (Venkatesh, Morris, Davis & Davis, 2003). Most importantly, UTAUT includes the Technology Acceptance Model and the Theory of Planned Behaviour, which have already been elucidated in this study.

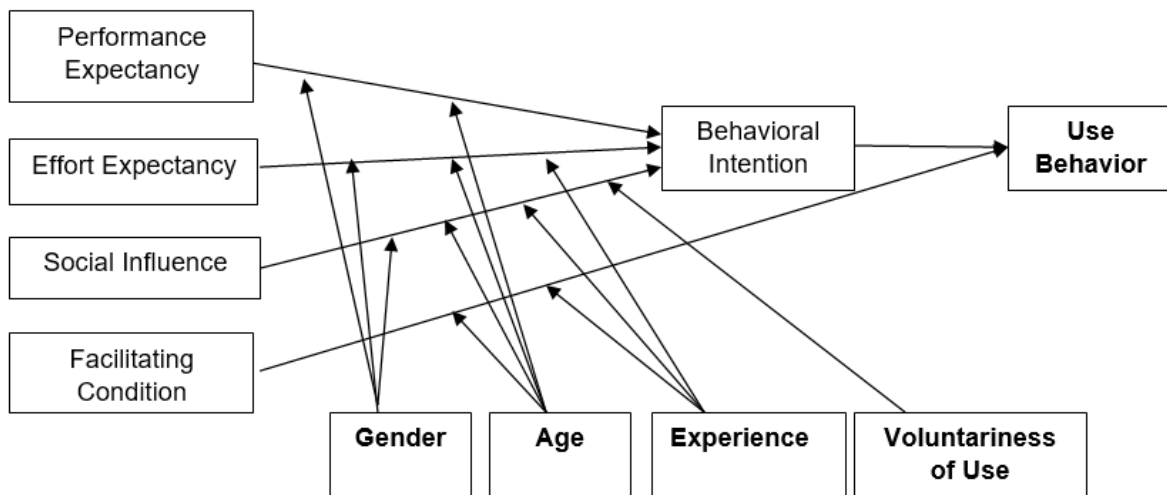


Figure 3. 6: The Unified Theory of Acceptance and Use of Technology

Source Venkatesh *et al.* (2003)

The UTAUT theory uses the variance perspective to address problems concerning technology adoption and use by individuals and organisations. The major tenants of the UTAUT are:

- *Performance expectancy* concerns the user's belief that technology increases task performance and productivity (produces desired results). Gender and age are moderators, implying that the effect is more likely to be more vital for men, particularly for younger men.
- *Effort Expectancy*: This pertains to the ease of using the system, which can be influenced by gender, age, and experience. Specifically, the impact of effort expectancy is likely to be more pronounced for women, especially younger women, during the early stages of their technology adoption.
- *Social Influence*: This text explores the impact of external factors, such as peer pressure, social norms, and support from colleagues or supervisors, on an individual's decision to adopt technology. These factors are influenced by gender, age, voluntariness, and prior experience. The effects are expected to be more significant for women, especially older women, in mandatory settings during their initial

experiences with technology. Be more pronounced for women, particularly older women, in mandatory settings during their initial encounters with technology.

- *Facilitating Conditions*: This refers to the availability of resources, support, and infrastructure essential for adopting and utilising technology. Key facilitating conditions include access to reliable internet, comprehensive training programs, and technical support—factors crucial for successful technology adoption and practical usage.

Instead of using the TPB and TAM, the study can utilise the UTAUT to investigate Technology acceptance is influenced by performance expectancy, effort expectancy, social influence, and facilitating conditions (Marikyan & Papagiannidis, 2023).

Literature shows that the UTAUT is one of the major theories that has significantly contributed to the literature on technology acceptance. Researchers in IS opt for this theory because it has demonstrable practical applications and empirical insight into technology acceptance due to its ability to compare major competing technology acceptance theories. Researchers have used the UTAUT with either a variance or process perspective, depending on their investigation. According to Venkatesh *et al.* (2003), UTAUT provides greater predictive power compared to other major technology acceptance models. Previous models often overlooked the interactive effects of certain constructs with personal and demographic factors. UTAUT addresses this gap by demonstrating the complexity of the technology acceptance process and how it varies with age, gender, and experience (Venkatesh *et al.*, 2003; Marikyan & Papagiannidis, 2023). The literature reveals that UTAUT has been changed to UTAUT2 and that both models were employed in diverse geographical contexts to explore the impact of culture on technology adoption, which proved the generalisability of the premises of the theory (Gupta, Dasgupta & Gupta, 2008; Venkatesh, Thong & Xu, 2012). In this study, UTAUT was adopted to investigate factors influencing the integration of ATs in inclusive education. Instead of the TPB and TAM, the study used the TTF and UTAUT in the Quantitative (QUANT) phase. The two theories enhanced the study's findings by establishing how the factors depended on each.

3.3.3 Process Theories

Besides using the variance theory in the quantitative phase of the study, the process perspective was used to gain insights into perceptions, lived experiences, and feelings of students with disabilities about ATs and attitudes towards these technologies. This study intends to adopt the DeLone and McLean Information Systems Success Theory as it

addresses some issues inherent in using technologies that can be adapted to the integration process.

3.3.3.1 DeLone and McLean Information Systems Success Theory

The DeLone and McLean (D&M) Information Systems Success Theory, Figure 3.7, is another process theory that may be utilised to provide valuable insights into IS success by identifying and explaining the correlations between their most essential dimensions of success (Sabeh, Husin, Kee, Baharudin & Abdullah, 2021). The D&M model is among the most well-known models for assessing IS success regarding technology uses and its outcomes (DeLone & McLean, 2003; Elazzaoui & Lamari, 2022). The model has received much publicity and has undergone much revision since its inception in 1992 (Sabeh *et al.*, 2021). This study uses an updated version of the D&M model Figure 3.7.

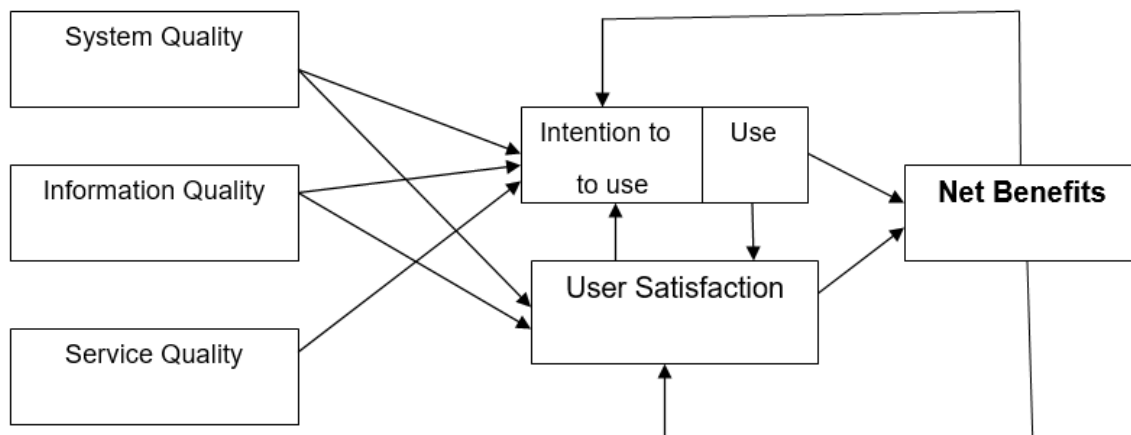


Figure 3. 7: DeLone and McLean information systems (IS) success model

model source: DeLone and McLean (2003)

The D&M model comprises six unique, interconnected, but interdependent success variables that must be considered while evaluating an IS in an organisation. System quality, information quality, service quality, intention to use/use, user happiness, and net benefits are examples (DeLone & McLean, 1992). The term *system quality* refers to the desired properties of the system itself. (DeLone & McLean, 1992; 2003; Petter, DeLone & McLean, 2008). *Information quality* means the quality of the system outputs, particularly the quality of the information provided by providers (Shim & Jo, 2020; Elazzaoui & Lamari, 2022). The term *service quality* describes the quality of support that users can get from the responsible service provider of the system (DeLone & McLean, 2003; Petter, DeLone & McLean, 2008). The *intention to use* refers to the user's intention to use the system to accomplish a task (Elazzaoui & Lamari,

2022; Sabeh *et al.*, 2021). According to Petter, DeLone and McLean (2008) and Petter and McLean (2009), *use* refers to the perceived actual use of the system by users to perform multiple tasks for their benefit. Finally, *net benefits* refer to the extent to which IS can contribute to the success of individuals, organisations, and groups (Shim & Jo, 2020; Kumar & Ayodeji, 2021; Suzianti & Paramadini, 2021). By applying this theory in this study, it is possible to investigate the system quality, information quality, service quality, purpose to use, and user satisfaction of the system from the point of view of the students living with disabilities on the ATs they are supposed to integrate into their disability units. The net benefits variable is important because it indicates the overall benefits of integrating ATs into academic studies at the university. Qualitative data was obtained, and thematic analysis was applied to understand the participants' concerns concerning the ATs in the disability unit.

3.3.3.2 Innovation Resistance Theory

Literature shows that users' motivation and resistance to technological advancements either stimulate or discourage their diffusion and acceptance (Huang, Jin & Coghlan, 2021; Yadav, Giri, & Chatterjee, 2022). The adoption, use, and integration of ATs in an institution can result from resistance to innovation, which can be explained using the Innovation Resistance Theory (IRT). The IRT is a theory that describes the phenomenon of resistance to change due to the Adoption of new ideas and technology by individual organisations (Ram & Sheth, 1989; Kautish, Siddiqui, Siddiqui, Sharma & Alshibani, 2023). The IRT is used to understand why individuals, organisations, and societies can be reluctant to embrace innovations and the factors influencing their willingness to adopt new technologies (Kautish *et al.*, 2023). The IRT purports that the denial, rejection, or deferral of a novel or innovative product or service by users, organisations or decision-makers demonstrates resistance to innovation (Kautish & Khare, 2022). This resistance could be due to users' and decision-makers' aversion to changing the status quo, which they perceive to be in contrast with their disposition (Ram & Sheth, 1989). This resistance stems from the failure of several inventions in the past, which have been documented in research on the dissemination of innovation (Friedman & Ormiston, 2022; Prakash & Das, 2022). Understanding the biases that cause resistance, deferral, or poor use of ATs in the disability unit can be accomplished using the IRT, and this can assist in the change perceptions of the users on the technology in question (Kautish & Khare, 2022).

In this study, the IRT was utilised to establish the factors that negatively influence the acceptance, use, and integration of ATs. The IRT identifies five key factors that may contribute to resistance to change in integrating an innovation at individual and organisational levels. The IRT enables researchers to study the resistance to innovation and resistance assumed to be due to functional and psychological barriers, technically referred to as active and passive

resistance (Koch, Kraemer & Heidenreich, 2021; Heidenreich, Killmer & Millemann, 2022). In this study, it is important to understand the nature of resistance leading to poor AT integration in inclusive education. Figure 3.8 shows Resistance of Innovation Model

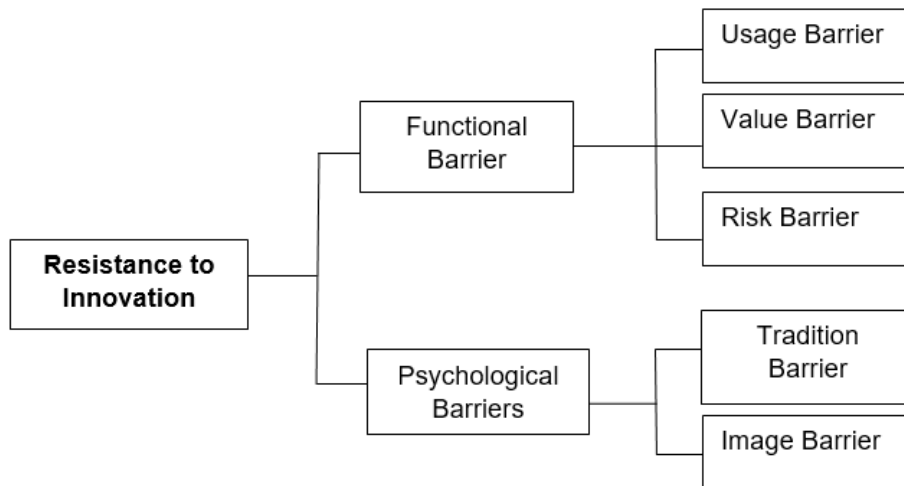


Figure 3. 8: Resistance of Innovation Model

The barriers illustrated:

- **Usage barrier:** Thinking that the technology is too complicated to use.
- **Value barrier:** Thinking that the innovation is expensive and useless. The expense exceeds its usefulness. It does not serve its purpose.
- **Risk barrier:** The innovation may malfunction during its use or may cause harm to the users when it malfunctions. An AT may malfunction during a test or exam, leading students to suffer academically. This can cause anxiety and emotional challenges among students.
- **Tradition barrier:** Students, lecturers, and stakeholders may prefer more straightforward traditional innovations, leading to the abandonment of newly introduced ones. An organisation may bring in the wrong innovation without consulting students.
- **Image barrier:** The innovation may mismatch the level of expectation of students who may think it is unnecessary. The same can apply to organisations that regard technology as a waste of investment as they perceive it as childish.

Furthermore, the identified barriers have been linked to several factors leading to resistance to innovation, which have been identified and relate to the following:

- **Innovations may threaten established institutions and conventions,** causing pushback from those who value the status quo.

- **Lack of understanding:** Unfamiliarity with innovation can make individuals and organisations hesitant to embrace it due to uncertainty about its influence on their lives and work.
- **Perceived risks and uncertainties:** Individuals and organisations may be hesitant to embrace innovations due to the uncertainty and potential dangers they bring.
- A lack of apparent benefits may hinder innovation adoption.
- **Economic and organisational factors:** Economic and organisational variables include expenses and resources.

The IRT was used to investigate the barrier to poor AT integration with students, stakeholders, lecturers, and the staff in the disability units to ascertain the challenges faced and what could be done to improve the integration of ATs. Results from four theories, two for Quantitative (QUAN) and two for Qualitative (QUAL), can enhance the chances of developing a framework for integrating ATs in inclusive education at the university.

3.5. Conceptual Framework

The conceptual framework summarises the provisions of integrating AATs in inclusive education, how historically disadvantaged rural universities can adopt the model, and how it may help the university integrate assistive technologies successfully and have a well-functioning unit since AATs integration overcome challenges students face. However, the main challenge is the lack of a proper framework to address students' needs. Therefore, the study aims to develop a framework for integrating assistive technologies in inclusive education in disability units at the University of Venda.

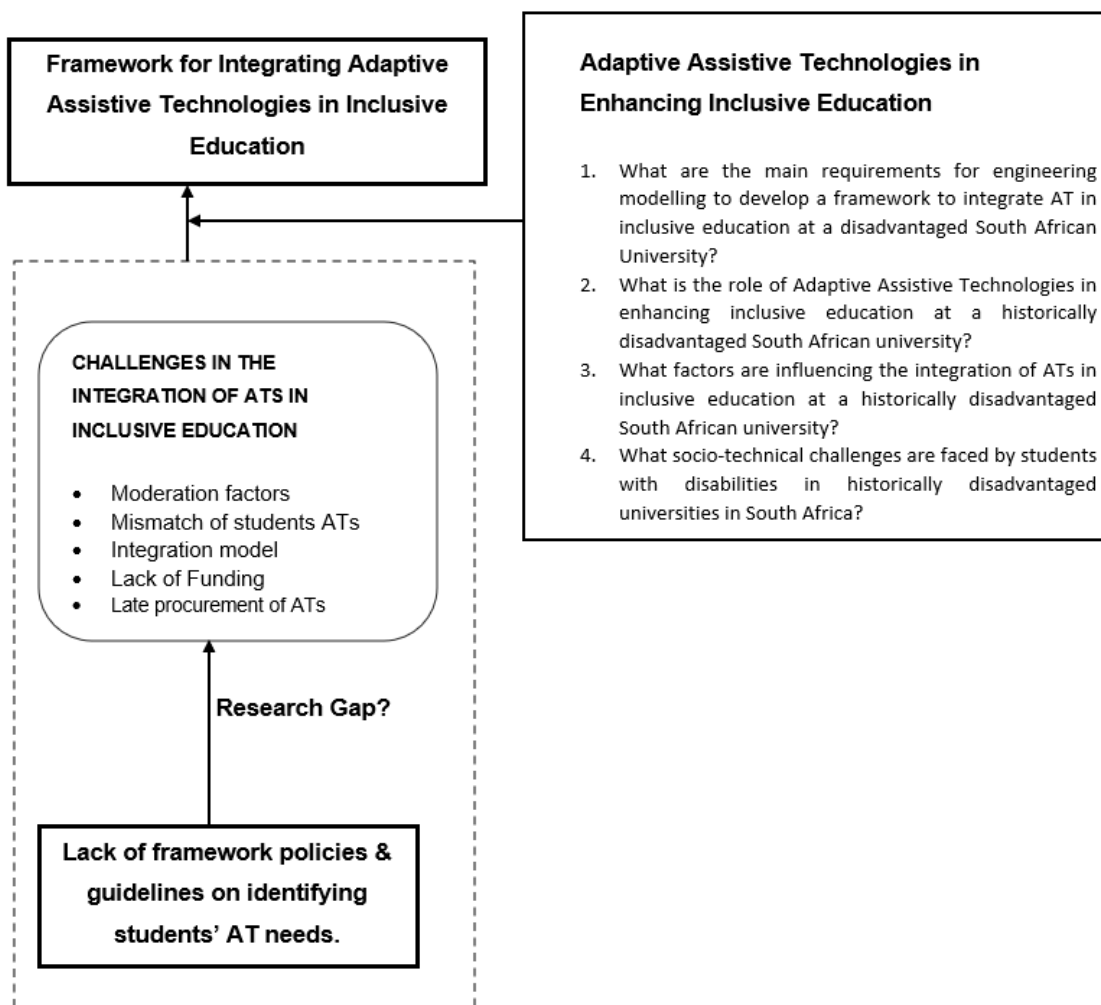


Figure 3. 9. Framework for Integrating AATs in an Inclusive Education Model

Source: Researcher's own construct

3.6. SUMMARY

This chapter examined the theoretical perspectives used in IS research: variance, process, and systems. By comparing these perspectives, the variance seemed to be the most popularly used in quantitative studies, while the process is utilised in qualitative research. In complex studies, researchers in IS encourage merging the two popular perspectives, variance and process perspectives. Each perspective has a set of models and theoretical frameworks with which it can be used. For this study, the TTF, a variance theory, was used in the QUAN phase to explain factors influencing the integration of ATs in inclusive education. The D&M process theory was used in the QUAL phase to gain insights into challenges and issues related to selecting ATs based on the qualities that users consider essential. A conceptual framework was proposed for the study. Details about how the models were used are given in Chapter 4.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 INTRODUCTION

The previous chapter presented the theoretical perspectives for this study, including variance and process crafted from the systems thinking theory. Furthermore, the TTF and D&M models were identified as the most appropriate lenses for the study. The former was used in the quantitative phase of the study, while the latter was utilised in the qualitative phase. This chapter presents a detailed description and justification of the research methodology used in this study.

4.2. RESEARCH METHODOLOGY

A comprehensive, methodical approach to the research design process, research methodology starts with research philosophies and continues with data gathering and analysis methods (Creswell & Creswell 2018). According to Wu (2012), research methodology encompasses all aspects of the research study's structure and design that steer and guide the inquiry conducted during the study's inception and execution. To select the research methodology for any study, the literature advises researchers to consider the data needed to answer research questions for the research problem being pursued (Zefeiti & Mohamad 2015; Scott 2016). The research methodology was essential in aiding the researcher in increasing the credibility of the research findings of any study (Creswell & Creswell, 2018).

This study uses quantitative and qualitative data to understand factors influencing the integration of ATs in inclusive education. Data about perceptions and feelings of lecturers, students with disabilities, staff at the disability unit, and decision-makers who procure ATs are required to answer the research question and to develop a suitable framework for integrating ATs into inclusive education. The research methodology process was adapted from Saunders *et al.* (2012) Research Onion Model (ROM) (Figure 4.1) because it guides the researcher on how the research methodology process can be formulated. The ROM was selected because of its clarity, ease of understanding, and implementation as a solution to the research problem pursued in IS (Melnikovas, 2023).

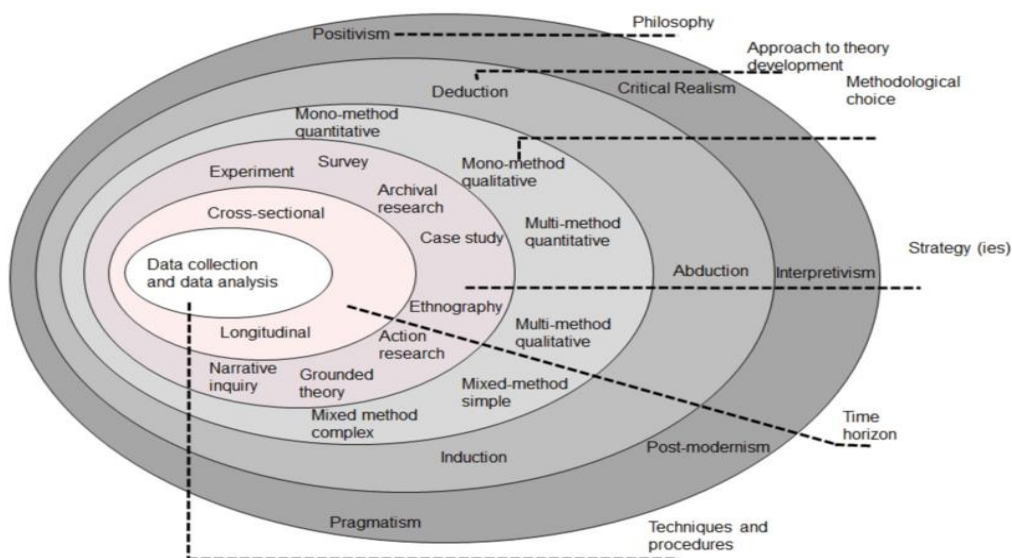


FIGURE 4. 1: Research Onion Model By Saunders *Et al.* (2009)

The adapted research methodology process is shown in Figure 4.2.

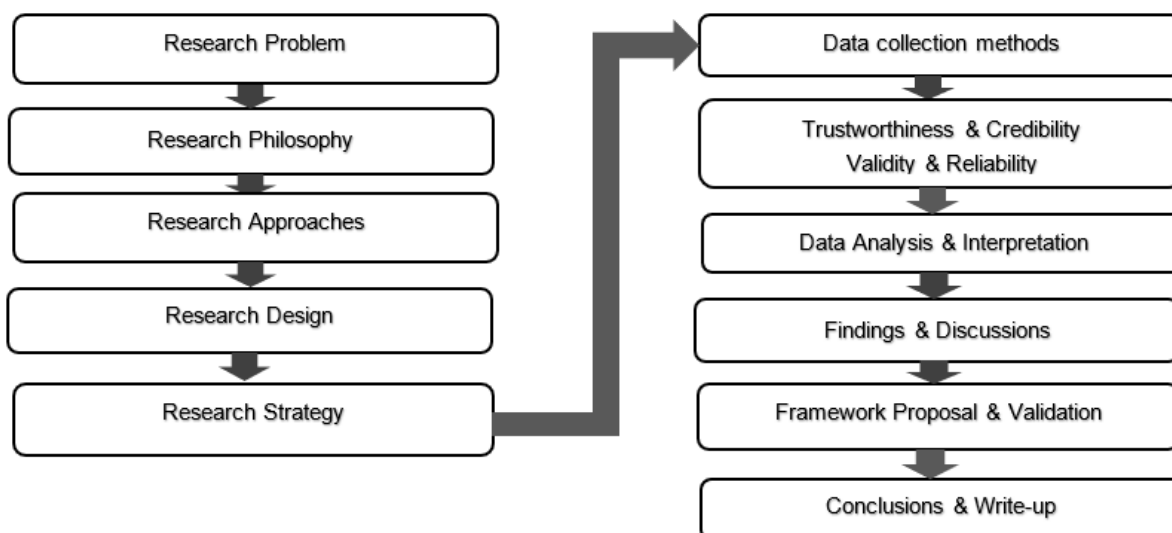


Figure 4. 2: Research Methodology Process

Adapted from Research Onion Model Saunders *et al.* (2012)

4.2.1 Research Philosophy

According to the Research Onion Model, choosing a research philosophy is the first stage of the research methodology process after understanding the problem. A research philosophy or paradigm represents a researcher’s worldview, which is usually needed when choosing the strategy, design, and methods for a research problem. This influences how a researcher understands the problem being studied. A research philosophy is a set of assumptions constituting a way of seeing reality (Farjoun, Ansell & Boin, 2015). According to Mkansi and

Acheampong (2012), a research philosophy is essential to the knowledge-creation process because it determines the nature of the developed knowledge. Existing literature advances three reasons that compel researchers to understand the connection between research philosophies and research methodology in their studies (Mkansi & Acheampong, 2012). A clear understanding of the underlying research philosophy can assist in selecting and justifying data collection techniques needed to support the research questions (Pathirage, Amaratunga & Haigh, 2016). Furthermore, the knowledge of research philosophy and methodologies can assist in choosing the appropriate literature for the study (Saunders, Lewis & Thornhill, 2012). This assists in reviewing literature and focusing on the sources that use similar research paradigms. Having insights into the benefits of using different research philosophies makes one more likely to improve the required research skills for selecting methods to implement in the study (Mkansi & Acheampong, 2012; Zefeiti & Mohamad, 2015). For these reasons, the Research Onion Model advances different research philosophies for use in different research contexts and elucidates “positivism, interpretivism, realism, and pragmatism”.

4.2.1.1 Positivism

Positivism is a philosophical perspective based on objectivism and requires scholars to present an unbiased analysis of social phenomena (Venkatesh, Brown & Bala, 2013). A positivist study is expected to collect data from large samples to get the most out of the world instead of looking at the research details (Mkansi & Acheampong, 2012). This means the conclusions arrived at in a study should be independent of the influence of the researcher's opinions and perception of the subject (Cameron, 2015; Rahman, 2017). Positivism asserts that genuine knowledge is purely based on sensory experience and can be attained by observation and experimentation. Therefore, the most appropriate means to investigate social reality is to comprehend human behaviour through observation and reason (Goldkuhl, 2008; Timans, Wouters & Heilbron, 2019). According to positivist ontology, methods, strategies, and instruments that are free from the researcher's influence must be used in the study to objectively give and quantify reality (Myers and Avison, 2011). According to positivism, knowledge can be measurable and objective (Edirisingha, 2012). A positivist study should empirically establish and exhibit the actuality (Henning, Van Rensburg & Smit, 2006). Existing literature demonstrates that positivism is a workable philosophy in a study that addresses a fixed and stable reality, where the researcher can adopt an objectivist viewpoint (Alharahsheh & Pius, 2020). The research's epistemological attitude must be independent of the respondents' beliefs and perceptions. The integration of ATs in inclusive education is likely to be influenced by several factors that can be difficult to determine using a positivist perspective. These results constantly change, leading to the researcher's and the participants' subjective

judgment of the study findings. Therefore, on its own, positivism may not be used to research multifaceted factors that may be influential social factors due to different contexts where ATs are usable. The environment in which ATs are used is fluid because of continuous changes in technologies used; the needs of students and those of stakeholders make the use of positivist philosophies on its own difficult.

4.2.1.2 Interpretivism

Interpretivism is another philosophical perspective that can be used in research to comprehend the research problem by analysing and describing individuals' views, experiences, feelings, collective values as well as behaviour meanings in varying societal backgrounds (Zalaghi & Khazaei, 2016; Alharahsheh & Pius, 2020). The integration of ATs in inclusive education is a social problem that can be understood from an interpretive perspective because of many influential factors that can be interpreted differently by participants whose objectives may differ. Understanding the experiences, sentiments, attitudes, perceptions, and knowledge of students, instructors, personnel at the disability units, and those involved in procuring ATs from an interpretive perspective is necessary to have clear insights into the integration of Assistive Technology . Interpretivism is treated as a lifeworld-based ontology that uses observation as both theory and practice filled with values (Leitch, Hill & Harrison, 2010). This means that the experiences of a researcher concerning the problem can influence how the truth is ascertained in this study. Unlike positivism, interpretivism's epistemological stance emphasises that knowledge is socially constructed by human agents (Paulinus and David, 2013). This is why a researcher is encouraged to understand the problem from a subjective point of view like a participant, rather than being an objective observer (Timans, Wouters & Heilbron, 2019). Those who advocate for interpretivism doubtlessly believe that using the interpretive perspective can lead to findings that illustrate various types of reality concerning solutions to the studied problem (Gray, 2013). In this study, interpretivism could provide better insights than positivism. Zalaghi and Khazaei (2016) believe that a study utilising an interpretive perspective is subjective. Therefore, researchers are expected to recognise their role in influencing the study's findings. In this study, interpretivism sought to enable the researcher to work with research participants in their natural settings to have an in-depth perspective on the feelings and experiences of participants about the research's epistemological attitude, which must be independent of the respondents' beliefs and perceptions of factors that influenced the integration of ATs in inclusive education in the university. Interpretivism has been criticised for being ineffective when used to decide mediation strategies (Kaushik & Walsh, 2019). Solving the problem requires collecting

quantitative and qualitative data during each research study stage. This means that mixed methods, well supported by implementing pragmatism, can be employed.

4.2.1.3. Pragmatism

Pragmatism is a research philosophy whose practical implications in IS research have been embraced (Goldkuhl, 2012). Since pragmatism places more emphasis on acts, events, and consequences than on antecedent conditions, its primary goal is to provide workable solutions to current issues (Alharahsheh & Pius, 2020). This study's problem was the lack of a proper framework for integrating ATs into inclusive education. The study's findings provided a paradigm for integrating ATs into inclusive education. This supports the use of pragmatism to help assess existing theories, experiences and beliefs of participants regarding how well they work in real-world applications (Schoonenboom & Johnson, 2017). Pragmatists reject the existence of a single, unchanging truth. Instead, pragmatism encourages researchers to understand truth as whatever is practical in solving a problem (Chandra *et al.*, 2015). For this reason, pragmatism emphasises that research must be kept outside theoretical debates over the nature of reality and truth but focus much on practical solutions to existing problems (Farjoun, Ansell & Boin, 2015). Therefore, pragmatism encourages researchers to critically evaluate research findings based on their application in real-life contexts (Farjoun, Ansell & Boin, 2015; Patton, 2015). According to Kelly and Cordeiro (2020), pragmatism is advantageous in organisational settings in which the creation of knowledge is closely linked to practice. By utilising pragmatism in organisational context research studies, researchers intend to move beyond objectivist conceptualisations when analysing and comprehending the connections between knowledge and behaviour in context (Farjoun, Ansell & Boin, 2015). Such studies seek to provide a workable solution for the problem being investigated. This is because pragmatism enables researchers to suggest applicable solutions to the current problems restricting the utilisation of ATS in inclusive education at the university. This makes pragmatism the most appropriate research philosophy for this study. The most appropriate research philosophy from those provided by the Research Onion Model was pragmatism because this study intended to use quantitative and qualitative methods to solve a practical problem of AT integration in inclusive education. The benefit of adopting pragmatism was that it provided a compromise between interpretive and positivist methods (Kaushik & Walsh, 2019).

Several advantages of pragmatism have been documented. Scott (2016), for example, claims that pragmatism is built on a willingness to adjust to specific conditions in which humans find themselves. Consequently, pragmatism may be utilised to research and solve real-world challenges that communities face. Underlying philosophical assumptions for pragmatism

encourage the use of *design science research* (a problem-solving approach), allowing the study to use many data collection techniques (Constantinides, Chiasson & Introna, 2012). Design science research enables the researcher to choose data collection and analysis procedures in the real-world realities of the impacted populations. The findings from the study can give insights into the study topics. From a research perspective, pragmatism emphasises action over principles (Saunders, Lewis & Thornhill, 2012). Concepts and practices should serve as standards for criteria, rightness, and worth, which should be analysed and evaluated in terms of utility, workability, and practicality (Scott, 2016). In contrast to interpretivism, which bases knowledge claims on the researcher's objectives, pragmatism generates knowledge that emphasises the significance of actions and changes (Goldkuhl, 2012). Table 4.1 shows each philosophical perspective's ontology, epistemology, axiology, and method fit.

Table 4. 1: Research paradigms in IS

	Positivism	Interpretive	Critical	Pragmatism
Ontology	<ul style="list-style-type: none"> ✓ Single, stable reality. ✓ Law like 	<ul style="list-style-type: none"> ✓ Multiple realities, ✓ Socially constructed 	<ul style="list-style-type: none"> ✓ The socially constructed reality, ✓ Power ✓ Discourse 	<ul style="list-style-type: none"> ✓ Singular and multiple realities (The researcher is external, multiple, and the view is chosen to answer the research questions best)
Epistemology	<ul style="list-style-type: none"> ✓ Objective ✓ Detached observer 	<ul style="list-style-type: none"> ✓ Empathetic ✓ Observer subjectivity 	<ul style="list-style-type: none"> ✓ Suspicious ✓ Political ✓ Observer constructs versions 	<ul style="list-style-type: none"> ✓ Practicality (focus on practical application to problems by merging views to help interpret data)
Axiology	<ul style="list-style-type: none"> ✓ Truth (Objective) ✓ Prediction 	<ul style="list-style-type: none"> ✓ Contextual understanding 	<ul style="list-style-type: none"> ✓ Contextual understanding ✓ Researchers' values affect the study. ✓ Inquiry is value-bound 	<ul style="list-style-type: none"> Multiple stances (Researchers include biased and unbiased perspectives)
Method	<ul style="list-style-type: none"> ✓ Quantitative but can also be applied to qualitative 	<ul style="list-style-type: none"> ✓ Qualitative ✓ Interpretation ✓ Interactional 	<ul style="list-style-type: none"> ✓ The adopted method depends on the research matter (Deconstruction, textual analysis, or Discourse analysis) 	<ul style="list-style-type: none"> ✓ Applies both qualitative and quantitative

Adapted from Orlikowski and Baroudi (1991)

4.2.3.4 IS knowledge research due to pragmatism philosophy.

The primary goal of IS research is knowledge development and distribution, which helps practitioners practice improvement (Constantinides, Chiasson & Introna, 2012; Chandra, Seidel & Gregor, 2015). Pragmatism might allow the researcher to learn what works in social circumstances. Goldkuhl (2012) distinguishes five categories of knowledge that IS researchers might develop while utilising pragmatism: revealing, critical, introspective, prescriptive, inventive, and dialogical. The different forms of IS knowledge that can be generated from programmatic research studies are shown in Figure 4.5. This study aims to contribute to the four knowledge types: revealing, reflective, prescriptive and innovative (Goldkuhl, 2012).

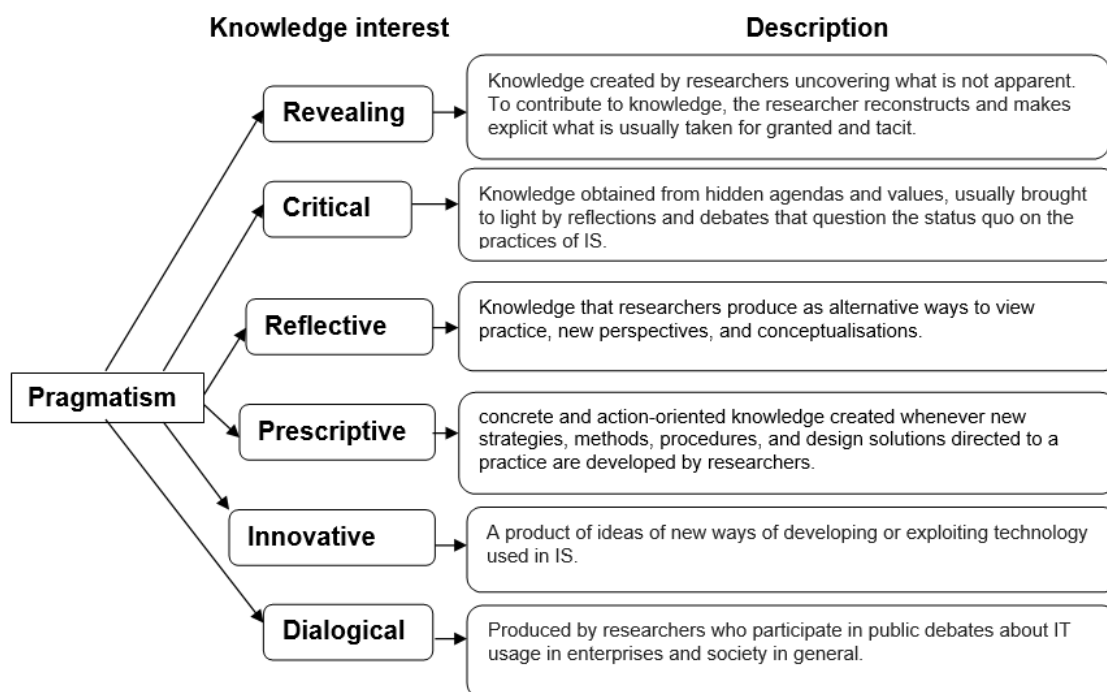


Figure 4. 3 : Possible Knowledge Generated by Pragmatic Research

Source: Loock (2021)

There is a plethora of literature attesting that pragmatic researchers can defend the benefits of theoretical knowledge to organisations and society by incorporating both positivist and interpretivism research viewpoints regarding theoretical knowledge (Chandra, Seidel & Gregor, 2015; Melnikovas, 2023). Pragmatic research studies employ the same research procedures as positivist and interpretivist studies. Because of the nature of the problem being addressed in this study, pragmatism was chosen because it accepts several design techniques, including the Design Science methodology utilised in IS studies (Melnikovas, 2023). This study employed functionalism to contribute to pragmatic knowledge through

revealing, prescriptive, reflective, and inventive knowledge. By using pragmatism, the study can adopt the Design Science research approach.

4.2.3 Research Approach

The three research approaches stipulated in the ROM are deductive, abduction, and inductive, and they are used in many IS studies for different reasons (Saunders, Lewis & Thornhill, 2012; Clohessy, 2017). Deduction and induction received attention in this study due to their possible use. Gioia, Corley, and Hamilton (2013) attest that the deductive and inductive reasoning approaches are comprehensive. The use of each research approach depends on the nature of the problem being solved and how the research study attempts to do that (Creswell & Cheryl, 2018). Literature shows that the deductive approach is appropriate when a study tests a hypothesis to confirm, refute, or modify a theory.

In contrast, an inductive approach allows one to conduct a study using observations or an idea to propose a theory from the findings (Kaushik & Walsh, 2019; Moyo & Looock, 2021). The deductive approach is limited because it focuses on testing and validating hypotheses (Moyo & Looock, 2021; Zalaghi & Khazaei, 2016). This approach is used in a confirmatory study where the hypothesis is tested to confirm a preconceived assumption or an anticipated association (Creswell & Cheryl, 2018). For this study, The deductive method alone is not appropriate since various unknown factors lead to a lack of an excellent framework to integrate ATs in inclusive education at the unit of study.

On the other hand, a study implementing an inductive approach focuses much on observing patterns and developing descriptions of theories using hypotheses (Eriksson & Kovalainen, 2015). Hypotheses and theories are typically used in the research process, enabling the researcher to alter the course of the research process (Worster, 2014; Schoonenboom & Johnson, 2017). According to Creswell (2013), an inductive study can be explanatory or exploratory because it aims to explain or describe key factors applying different research methods.

The inductive approach is used to facilitate the development of a framework based on data collected from students living with disabilities, lecturers, staff in the disability unit, and those who procure ATs about the lack of integration of ATs in inclusive education at the university. This study capitalises on the strength of the inductive approach, which takes a bottom-up strategy, beginning with observations and ending with a broader and more generalised theory. The inductive approach is regarded as effective for discovering anomalies and patterns. It might lead to formulating possible hypotheses, models, and a framework to provide the

required answer to the current problem. In essence, the advantages of the inductive approach can be summarised as suggested by Jebreen (2012):

- assisting in integrating and summarising several sets of raw data in a single research;
- encouraging the establishment of links between research goals and outcomes that enhance the accessibility of study findings and conclusions for the general public and fellow researchers; and
- supporting the theory's proposition and evolution or the growth of knowledge derived from experiences and data-driven procedures

For this study, deductive and inductive approaches were used at different points.

4.2.4 Selection of Research Designs

Worster (2014) defines a research design as a framework that addresses all of a study, from a description of the problem to data-gathering methods. A research design is supposed to link data gathered to theoretical arguments made in the study (Saunders, Lewis & Thornhill, 2012). According to the literature, the three research designs used in most studies include quantitative, qualitative, and mixed methods, and the choice of each depends on the questions the research seeks to answer, the types of data needed to answer the questions and how the data was analysed (Omair, 2015). This means that each design in a research study serves a specific purpose, and each of them needs to be done carefully.

4.2.4.1 Quantitative designs

In quantitative research, quantitative designs demonstrate objectivity in presented data, correctly forecast events, and create findings which can be generalised to populations and contexts other than those in the study (De Villiers, 2012). According to Melnikovas (2023), quantitative designs are popular in natural sciences, where controlled laboratory trials comprise the majority of research investigations. Similarly, Myers and Avison (2011) posit that quantitative designs utilising studies have to collect numerical data or data that can be converted into numbers and then statistically analysed. Quantitative studies utilise quantitative methods to estimate the size and trends in specified populations (Punch, 2013). Literature shows that quantitative designs involve using surveys and experiments as data-gathering tools, followed by statistical analysis, which aims to identify what has to be measured and tallied (Oates, 2006). Furthermore, quantitative designs are essential when a study seeks to

promote a positivist point of view whereby the problem being studied deems the researcher as an independent object whose influence on the study outcome is negligible.

4.2.4.2 Qualitative designs

Researchers can arrange investigations to gather and analyse qualitative data expressed as words, text, and actions with the aid of qualitative designs (Maxwell, 2013). Studies have demonstrated the importance of qualitative designs for understanding people in their natural environments, analysing the words, actions, and intentions expressed, and reflecting on emotions, social contexts, and experiences in actual settings (Creswell, 2013). A study utilising a qualitative design tends to prioritise settings that make participants feel calm in an inductive, participative, and flexible way (Osborn, 2014). This study used a qualitative design when choosing research methods for data collection and analysis. Similarly, Myers (2020) posits that qualitative designs are suitable for research studies that delve deeply into social and cultural issues. This can make a researcher active in interacting with research participants by using data collection methods such as focus groups, fieldwork, interviews, and observations (Creswell, 2014; Moen & Middelthon, 2015). Data analysis techniques such as narrative, thematic and content analysis are commonly utilised in qualitative studies. These data analysis techniques are largely subjective because they include many participants and researcher participants (Braun & Clarke, 2006; Castleberry & Nolen, 2018). The disadvantage of qualitative research studies is their emphasis on the meanings attached to participants' experiences and overlook sensitivities of such contexts (Silverman, 2010). Another criticism of qualitative designs is their use of small sizes of research samples, their bias in sampling and their interference with participants during the data-collecting stage (Constantinides *et al.*, 2012). In qualitative studies, small sample sizes are used, which limits the generalisation of findings to larger populations. Sampling biases can raise concerns about representativeness. Qualitative designs allow researchers to interfere with participants while collecting data (Llave, 2017; Momani & Jamous, 2017). Therefore, such constraints should be considered when the design is chosen.

4.2.4.3 Mixed-methods research designs

Several information systems studies successfully implemented mixed-methods designs in solving problems because these designs allow the research to utilise quantitative and qualitative methods of data collection and analysis that can provide a better understanding of the research problems instead of design only (Creswell & Creswell, 2018; Timans, Wouters & Heilbron, 2019). Cameron (2015) purports that mixed methods designs require a study to

approach a problem that does not use quantitative or qualitative design. According to Moen and Middelthon (2015), Mixed-method designs are used in studies based mainly on pragmatism instead of simple principles. De Villiers (2012) and Punch (2013) independently advocate using mixed-methods designs to overcome weaknesses inherent in either quantitative or qualitative research in studying a complex problem. The integration of ATs in inclusive education at a university is essential to understand, so developing a framework to guide the integration process requires data from the quantitative findings to be used in the qualitative phase of the study. The advantage of using a mixed-methods design is that it enables a researcher to freely choose data collection and analysis techniques that clearly understand the research problem without being limited to a single theoretical perspective (Creswell & Cheryl, 2018). The study seeks to use two theoretical frameworks from variance and process perspectives. Additionally, the researcher can gather, examine, and analyse quantitative and qualitative data in a single study using a mixed-methods research design (Cameron, 2015). A mixed-methods design was used to develop and enhance the findings and conclusions of the study to contribute knowledge in IS research and publish a report from the study's findings in which quantitative and qualitative techniques were used (Schoonenboom & Johnson, 2017). Literature shows that IS studies that use mixed-methods designs get in-depth insights into investigated problems and develop novel theoretical knowledge for future use (Brown & Bala, 2013).

This study used explanatory sequential mixed methods (Figure 4.3) because it started collecting and analysing quantifiable data obtained from a sample of seventy-one respondents to understand the factors impacting the integration of ATs in inclusive education in the institution. A follow-up to the survey was to collect qualitative data on the problem of interest based on participants in their natural settings. After confirming and validating the findings of the quantitative phase, the insights from the qualitative data assisted in proposing a framework for integrating ATs in inclusive education.

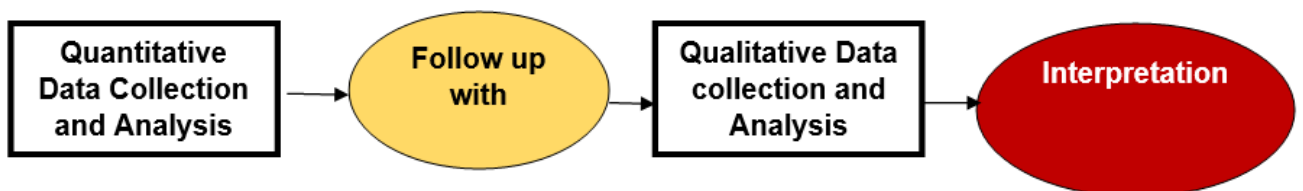


Figure 4. 4: Explanatory sequential mixed-methods design.

Figure 4.4 illustrates that explanatory sequential design begins with quantitative data collection and analysis, then follows up with qualitative data collection and analysis leading to interpretation and listing of findings. This is intended to determine what quantitative results must be explained further.

4.3 RESEARCH STRATEGY – DESIGN SCIENCE RESEARCH

After the research designs, the Research Onion models requires the study to choose a research strategy depending on the design and research philosophy used. This study adopts a pragmatism perspective, which focuses on solving an existing problem with a solution that works. Among a plethora of existing research strategies, the Design Science Research (DSR) strategy (Figure 4.4) was used. Design science research is a strategy in which a designer answers questions relevant to human problems by creating innovative artefacts, thereby contributing new knowledge to scientific evidence (Laumer & Eckhardt, 2012). DSR is a problem-solving approach within the pragmatic paradigm to advance human knowledge by creating innovative artefacts (vom Brocke, Hevner & Maedche, 2020). As a problem-solving methodology, DSR focuses on generating design knowledge and enhancing understanding by developing novel solutions to real-world problems (Hevner, March, Park, & Ram, 2004). The designed artefacts are both valuable and fundamental in understanding that problem. This experimental study aims to develop a framework integrating ATs in inclusive education.

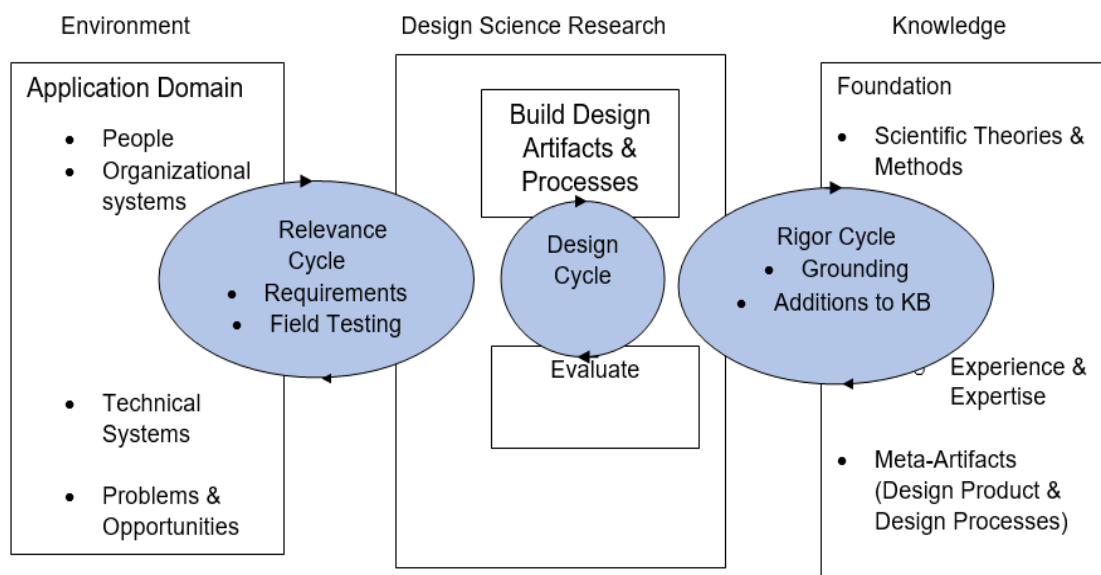


Figure 4. 5: Design science research model (Weber, 2010)

In developing and validating a framework for Inclusive Education, Design science researchers work on understanding, explaining, and improving information systems (García Reyes, 2013).

4.4 POPULATION, SAMPLE, SAMPLING TECHNIQUE, AND SAMPLING FRAME

The following is the layout of the study population sample and sampling frame:

- i. The population for this study included all registered students living with Disabilities, Academic staff, and the DSU department at the University of Venda.
- ii. Sampling Technique

Purposive sampling was used to select the respondents to participate in the study, as shown in Table 4.2. The participants in the study must conform to the following criteria:

Table 4. 2: Sampling Technique

Sampling Cohort	Reason for inclusion in the sample	Criteria for inclusion
DSU staff, academic staff, and registered students with disabilities	Raw data – share their knowledge and experience model.	All students who are living with disabilities and staff who deal with students with disabilities.

- iii. Sample frame

Several considerations were taken to determine the appropriate size. These include time and financial constraints and sample sizes used in previous qualitative doctoral studies. The study did not have a defined sample size because it utilised a census approach. Questionnaires were distributed to all students living with disabilities and those who registered with the unit for academic support, totaling 99 individuals. However, only 71 students responded to the questionnaires. The Cronbach's alpha coefficient was calculated to assess the reliability of all 71 items in the questionnaire, yielding a value of 0.872. This result is considered very high and acceptable, indicating that the instrument effectively measures the intended constructs. A qualitative request for an interview was sent to all five staff members at the disability unit. Four agreed to participate in the interview. Additionally, the request was extended to 14 academic staff members directly involved with students living with disabilities, but only one agreed to be interviewed.

4.5 DATA COLLECTION PROCEDURES

This study utilised the data collection and analysis steps in Figure 4.6 (Creswell & Plano-Clark, 2011). According to the model, data were collected and analysed for each stage, and then findings were interpreted before being integrated during discussions. The quantitative phase employed the variance theory and the TTF, while the qualitative phase applied the process theories, the DeLone and Mclean IS, and the Innovation Resistance. The TTF was used to determine the variables to be measured, and these were obtained from various literature sources from studies conducted about ATs in inclusive education. To get more insight into the problem, qualitative data was required to corroborate the quantitative findings, hence using the process theories.

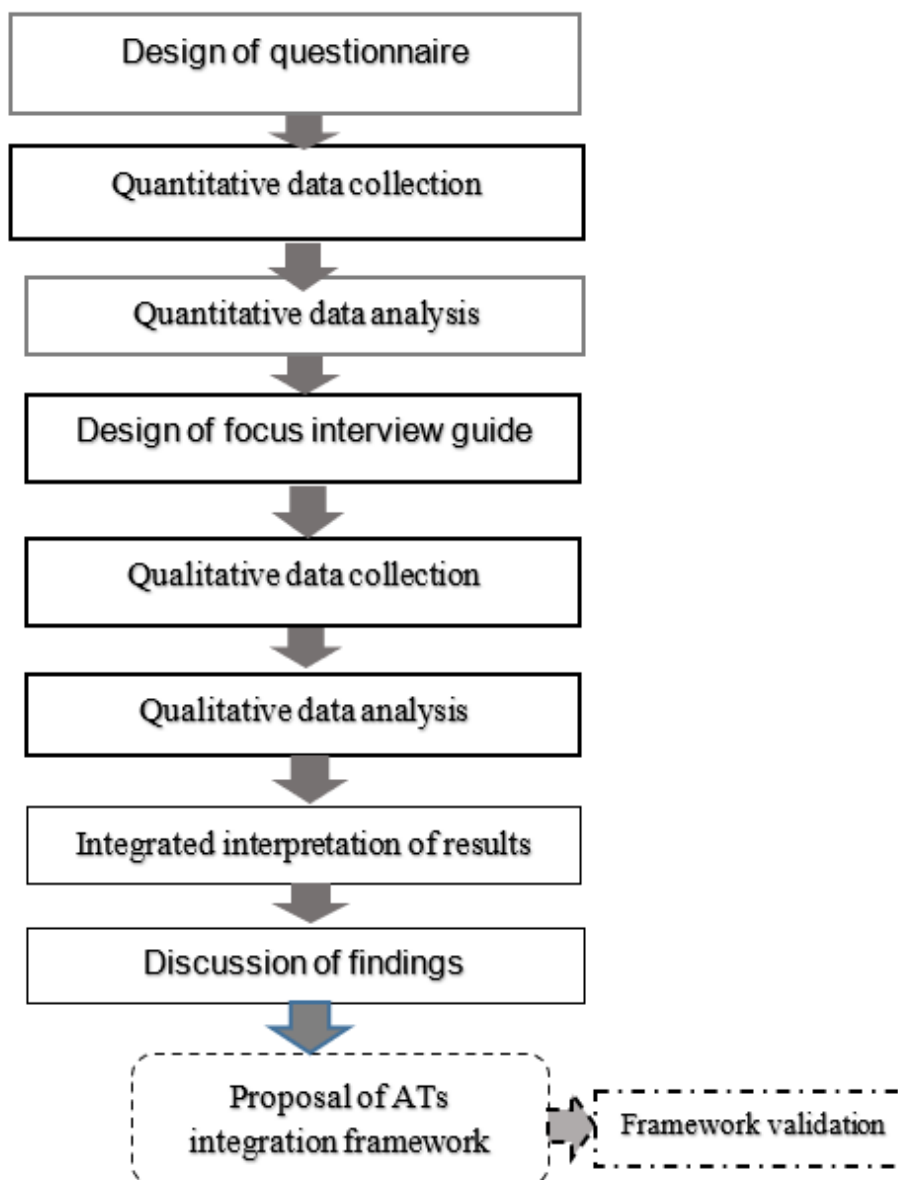


Figure 4. 6: Data collection and analysis

Adapted from Creswell and Plano-Clark (2011)

4.5.1 Instrument development and pilot-testing for quantitative data collection

An online questionnaire was developed from constructs deduced from the literature review and existing questionnaires used for similar studies. Three sections comprise the questionnaire: demographics, factors influencing the integration of ATs in inclusive education, and strategies to overcome challenges faced. Churchill (1979) advocates a questionnaire design format involving many steps. Such a questionnaire was used in a study by Zefeiti and Mohamad (2015). Zefeiti and Mohamad's (2015) questionnaire design was adapted by merging and removing some steps that did not apply to this study. Content validation was included as a step in the questionnaire. Figure 3.7 illustrates the steps used in formulating the questionnaire.

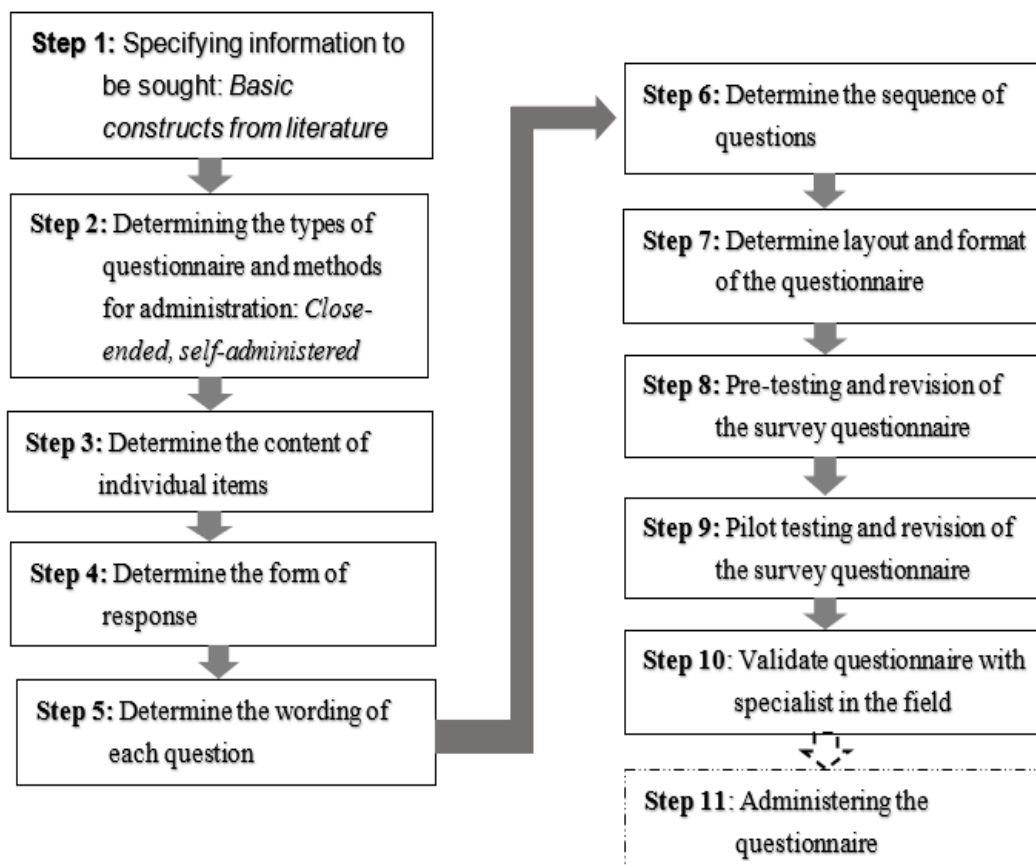


Figure 4. 7: Steps in designing the questionnaire.

Adapted from Zefeiti and Mohamad (2015) & Moyo and Look (2022)

The questionnaire was developed following steps 1 to 6; all other essential steps were finished. Ten students completed a pretest of the questionnaire to look for grammar mistakes,

repetitive questions, issues with the item arrangement, and unclear or problematic questions. Based on their pre-test responses, the questionnaire was edited by moving, rewording, and deleting items. Four students and one lecturer participated in a pilot study of the updated questionnaire. This resulted in further changes being made to the questionnaire. The two supervisors did content validation. The final questionnaire was reviewed by a statistician who scrutinised the measures and scales employed. The assessed items, constructions, and content satisfied the validators.

The final questionnaire was made of these sections:

- Section 1: Demographic information of respondents
- Section 2: Factors influencing the adoption integration of ATs in inclusive education
- Section 3: Strategies used to integrate ATs in inclusive education in Higher education
- Section 4: Challenges faced in integrating ATs and measures taken to overcome them
- Section 5: Key elements considered while developing a framework for incorporating ATs into inclusive education

4.5.1.1 Survey Questionnaire Method

Online questionnaires collected quantitative data. The questionnaire link was sent to 99 respondents, and 71 returned completed online forms.

4.5.1.2 Data analysis in the quantitative phase

The data from the online questionnaire underwent a comprehensive process, including verification, cleansing, and coding in an Excel worksheet. These steps were followed by their importation into Statistical Package for Social Scientists (SPSS) Version 29 for quantification. The results were then presented as descriptive statistics, frequency tables, and Chi-square tests. The Chi-squared tests were crucial in examining the relationship between socio and technical challenges and selected demographic characteristics such as level of study, duration of use of ATs, training type of disability, and frequency of use of ATs. The test of dependency of demographic variables and other variables revealed no significant associations among the variables, ensuring the integrity of the study.

The ratings were distributed based on the frequency of use of Assistive Technologies (ATs), accompanied by descriptive statistics including mean (M) and standard deviation (Std). A mean of 3.0 or higher indicates high-frequency use, between 2.0 and 3.0 indicates moderate use, and below 2.0 indicates weak use. Respondents were asked to rate the frequency of AT use available in the disability unit.

Graphs were generated to illustrate the types of AT assistance sought from the disability unit. Understanding the characteristics of devices used in the disability unit was deemed crucial. Respondents rated their familiarity with these characteristics, their frequency of logging into devices and accessing internet content, and the extent of disorientation experienced when navigating online. The appropriateness of ATs provided for completing academic tasks was also assessed.

Tables were compiled to summarise findings that revealed physical disability as the most prevalent among respondents. Respondents specified the types of disabilities requiring the use of ATs for learning. Various challenges associated with AT use among students with disabilities were also identified.

4.5.1.3 Data Collection using interviews

According to Creswell and Cheryl, 2018, interviews are a valuable method for learning about participants' viewpoints, emotions, experiences, beliefs and explanations of actions and events that occur within their borders. Researchers are encouraged to utilise the interview data collection method due to the added advantage that it facilitates interaction between the researcher and participants (Kaushik & Walsh, 2019), and this has been found to allow the researcher to get as much information as possible about the research study (Ibrahim & Musah 2015). For this study, the interview method was appropriate as it assisted the researcher in collecting data on issues being investigated concerning the integration of ATs at the university being studied and providing answers to research questions.

The interview instrument adopted was a semi-structured guide with questions intended to solicit information from purposively selected participants from various departments in the university. The other advantage of semi-structured interviews is that they allow the interviewer to ask similar questions to enable participants to freely explain the phenomenon as they see fit (Rubin & Rubin, 2012; Roulston, 2014).

Literature shows that all interviewees should be briefed on the purposes of the interview or study before the interview sessions and asked to consent to be interviewed (Roulston, 2014; Kaushik & Walsh, 2019). In this study, most interview sessions were conducted online at a convenient time for the interviewees. Permission to record the sessions was sought from each interviewee. The recordings were replayed at the end of the session, during which each interviewee confirmed the transaction as an actual recording. Participants were asked to complete an informed consent form before the interview sessions. Each interview session took between 20 and 30 minutes. English was used as a communication medium in all the interviews. The interview process was terminated when the researcher realised that the

respondents were giving almost similar responses and differing expressions. This was decided to be the saturation point when interviewees repeated the same ideas as answers to the questions. According to Ando, Cousins, and Young (2014), saturation is a situation where an information redundancy state is reached when gathering data. According to Braun, Clarke, Hayfield and Terry (2019), saturation is collecting data until no new information is generated from participants. According to Namey, Guest, McKenna, and Chen (2016), if saturation is followed in data collection in a qualitative study, there is a high chance that a tiny sample is likely to be used. To safeguard the data from the interviews, the audio recordings were stored in a memory card, USB, and backed up on Google Drive for easy access when needed at short notice.

4.5.1.4 Analysis of qualitative data

Qualitative data analysis has been defined as the process of picking out noteworthy quotes from transcripts, coding data using relevant concepts, and creating themes (Creswell & Plano-Clark, 2019). Qualitative data consists of text and words that should be analysed to establish the participants' meaning based on their "feelings, experiences, beliefs, knowledge, and behaviour" (Guest, MacQueen & Namey, 2012). This means that qualitative data analysis entails "reducing data, in-text, and words, to codes to represent themes or concepts, and this process may use quantitative techniques to determine patterns in the relationships among the codes" (Castleberry & Nolen, 2018).

Audio interviews were transcribed and stored in a separate MS Word file for each transcript, which was then imported to Atlas.it23 for thematic data analysis. According to Maguire and Delahunt (2017), thematic data analysis enables researchers to uncover patterns or themes within a qualitative data set.

According to Castleberry and Nolen (2018), thematic analysis is a basic technique for learning critical abilities for qualitative data interpretation. Most research using thematic data analysis states that this method is easy and free from theoretical or epistemological perspectives (Maguire & Delahunt, 2017). This study benefited from the thematic framework for qualitative data analysis suggested by Clarke and Braun (2013), shown in Figure 4.8, adapted by Moyo and Looock (2022). The thematic analysis framework consists of six steps followed in this study to complete data analysis successfully.

Thematic data analysis started with data familiarisation (Morgan & Nica, 2020). This was after the researcher ensured that important information was taken out of the transcripts and audio recordings by periodically reviewing the material. The researcher meticulously analysed the interviewees' critical thoughts, experiences and perspectives before beginning to discover and

describe related ideas based on the connotations communicated in the narratives. The process of analysing quantitative data was made easy by using the Atlas.ti23 program, which enabled the researcher to move forward and backward while identifying similar concepts and trends in different transcripts.

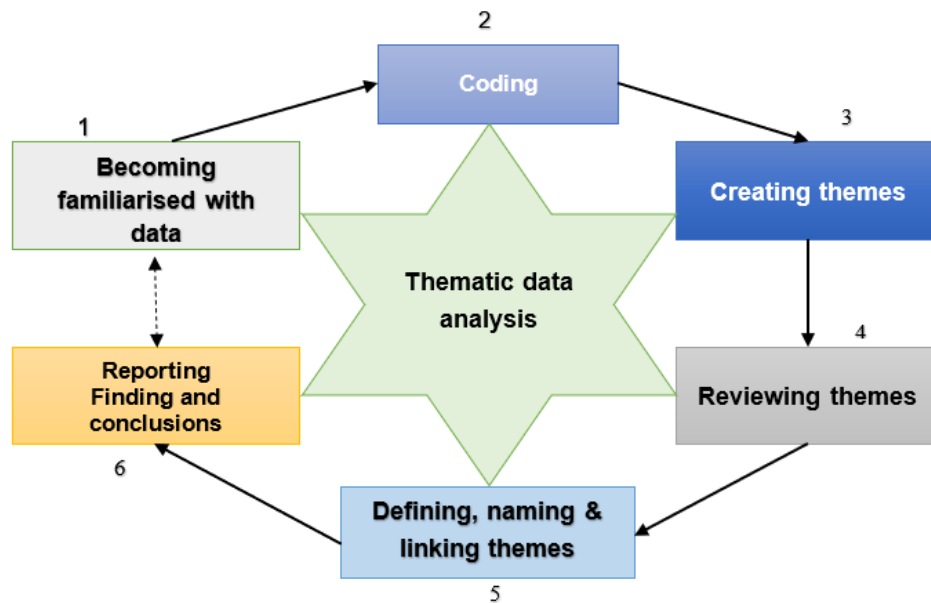


Figure 4.8: Six steps for thematic data analysis

Adopted from Moyo and Look (2022)

Preliminary codes were found to help classify important and fascinating concepts in the second thematic analysis step (Castleberry & Nolen, 2018). Maguire and Delahunt (2017) recommend rigorously summarising data into smaller analysable units by developing categories and concepts based on the data to handle initial coding. In the context of this study, the first tagging of thoughts resulted in various codes that required further investigation. After reviewing the transcripts numerous times, the researcher decreased the codes by thoroughly analysing and comparing the thoughts.

The researcher compared themes and sub-themes before determining whether to combine, enhance, divide, or eliminate the original subjects (Morgan & Nica, 2020). This step was essential because the themes in this study had to be connected to each research topic.

Determining, labelling, and connecting themes to research questions was the second-to-last step in the thematic analysis procedure. During this step, the researcher examined and analysed the data set to find themes and potential sub-themes and then connected those themes to sub-research questions (Agostino *et al.*, 2013). To ensure that themes and sub-themes were appropriately recognised, thematic analysis was conducted again (Maguire & Delahunt, 2017). To properly convey the essence of each subject, the researcher provided

clear working definitions and theme labels. This step was crucial, according to Clarke and Braun (2013). The themes leverage the data from the interview to craft a compelling narrative.

According to Clarke and Braun (2014), the last step in a thematic data analysis framework requires the researcher to report the study's findings. Similarly, this step was followed by presenting the quantitative research results in Chapter 5 and the qualitative research results in Chapter 6 respectively. Chapter 7 presents the discussion of the findings as part of the report to provide grounds for developing the framework. Extracts from the interviews were used selectively to corroborate the findings in the quantitative research.

4.6 ETHICS

Any ethical considerations should also be detailed in this chapter. These should be described if unique ethical procedures were used to handle, for instance, animals or kids. Ethical considerations were maintained throughout the study to safeguard the participants' rights. Informed consent, voluntary participation, confidentiality, privacy, and safeguarding participants from harm are all factors the researcher considered while requesting permission to perform the study.

4.6.1 Permission to conduct the study

For quality control and approval, the study proposal was given to the University of Venda Higher Degrees Committee and then to the School of Management Sciences. An application was submitted to the University of Venda's Research Ethics Committee for ethical approval to conduct the study. Data gathering started after receiving ethical clearance from the Ethics Committee.

4.6.2 Informed consent

Respondents were informed about the objectives and purpose of the study, the voluntary nature of participation, and the time required to complete the questionnaire and participants in interviews before receiving signed consent forms. The consent forms were distributed to those willing to participate only after they decided to engage in the study.

4.6.3 Voluntary participation

The researcher ensured that the participants knew that their involvement was voluntary and that they could withdraw from it at any moment if they felt threatened or uncomfortable before being involved in the research project.

4.6.4 Confidentiality and Privacy

Participants received assurances that their names would not be linked to the consent form and would be kept confidential. They were also informed that the researcher and the supervisors alone had access to the information they provided for the study.

The participants were given consent forms and advised to omit their names to ensure privacy. In the case of illiterate participants, the researcher explained that they did not include the respondents' names anywhere in the study. (Gauche *et al.*, 2017).

4.6.5 Participants' protection from harm

Shannon and Risk (2009) believe that harm and risks to participants must be minimised, simultaneously maximising the benefits of the study. Furthermore, the researcher was expected to treat variations in a research population such as gender, race, religion, politics, society, or other factors sensitively and appropriately at every study stage. The researcher ensured that the participants were not harmed physically, psychologically, or emotionally. To prevent anxiety and psychological trauma during interview sessions, the researcher suitably created non-judgmental questions. Furthermore, potential risk was examined, and the study took precautions to prevent it. Furthermore, if some participants were harmed, the researcher could follow up and refer the participants for counselling.

4.7 SUMMARY

The chapter presented a detailed research design and methodology used in this study. The selection of the design and methodology was informed by the data needed to answer research questions that provide insights into the solution to the problem of a lack of framework for integrating ATs in inclusive education at the university. The study used quantitative and qualitative data from an online closed-ended questionnaire and interviews. Data was analysed using quantitative techniques as well as thematic analysis. The findings will be discussed in the next chapter.

CHAPTER 5: ANALYSING AND INTERPRETING QUANTITATIVE DATA RESULTS

5.1 INTRODUCTION

This chapter presents data analysis which is divided into three sections: **Section A** presents demographic information, **Section B** presents socio-technical challenges faced by students with disabilities in historically disadvantaged universities in South Africa, **Section C** presents Technical skills and **Section D** presents Requirements for Framework for integrating AT in inclusive education. It includes quantitative data analysis and the reliability of the measurement scales used.

5.2 QUANTITATIVE DATA ANALYSIS

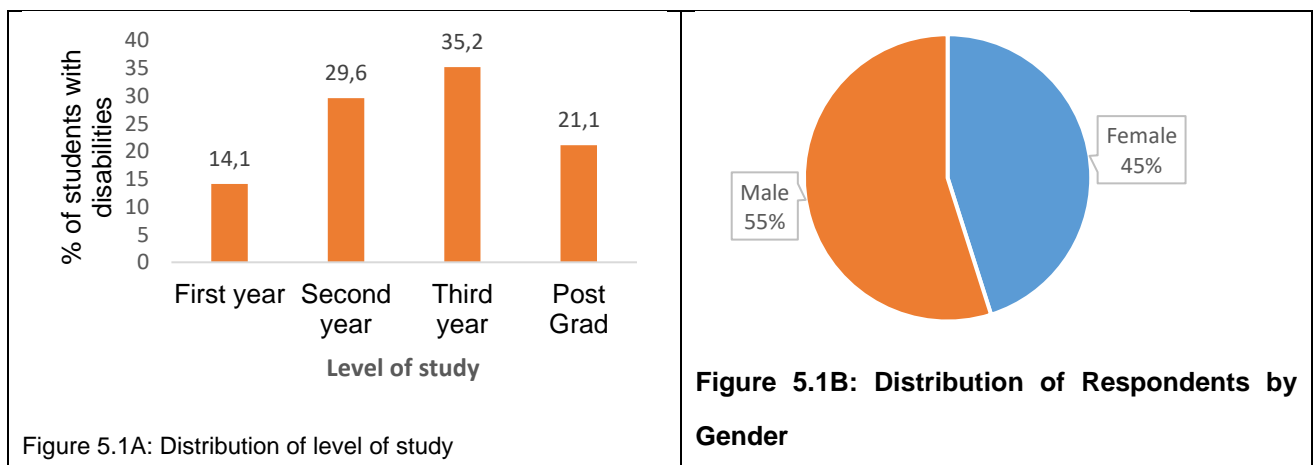
A self-administered online questionnaire was distributed to 99 students registered for support at the disability unity. Seventy-one (71) respondents completed questionnaires were returned, resulting in a response rate of 71,7%. Quantitative data was analysed using the Statistical Package for Social Science (SPSS) Version 29 to produce frequency tables, descriptive statistics, and chi-square tests.

5.2.1 RELIABILITY OF THE MEASUREMENT SCALES USED

Using the Cronbach alpha, the reliability of all 71 of the questionnaire's items was assessed, and the result was 0.872, a value deemed very high and acceptable. This indicated that the instrument measured what it was designed to measure.

5.2.1.1 Section A: Demographic information

Seven items were used as source data for demographic information: Level of studies, type of disabilities, use of AT, duration of use of AT, source of information of AT device, ease of getting devices, and training received on the use of AT. The results are shown in Figure 5.1.



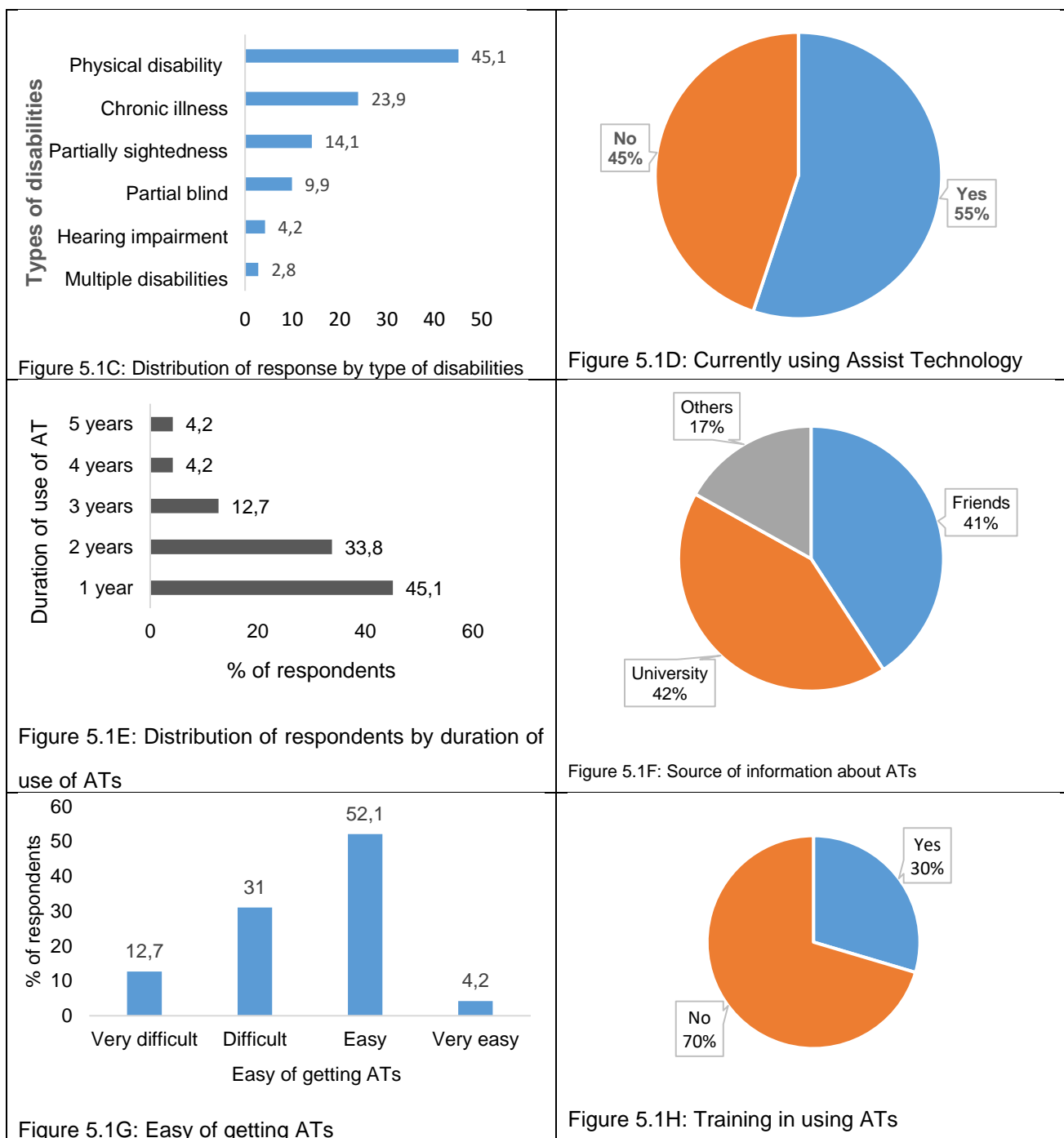


Figure 5. 1: Demographic information about the sample used

Demographic information was important in this study to indicate the characteristics of respondents. Eight items were used to collect the data, as shown in Figure 5.1 (5.1A to 5.1H charts).

Figure 5.1A shows that respondents were fairly distributed in four levels of studies, with more than 60% in the second and third levels. A considerable 21% of the respondents were pursuing postgraduate studies. This implies that the data was collected from students who have been

in the university for more than one year. The number of students using the disability unit seems to have been on an upward trend from the first to third year as students became acquainted with the university facilities.

The results in Figure 5.1B further show that more male students (54.9%) used the disability unit than females (45.1%). More male than female students visiting the unit seem to suggest that the former could have had more knowledge about the unit than the latter or that disability was more common among male students than female students; hence, the latter tended to visit the unit less.

Concerning the prevalence of disabilities, the results in Figure 5.1C show that physical disability was the most dominant (45.1%), followed by a chronic illness, which accounted for 23.9%, while hearing impairment and multiple disabilities were the least, as indicated by 4.2% and 2.8% of the respondents, respectively.

Concerning the current use of ATs, as shown in Figure 5.1D, 59.2% of the respondents affirmed being active users of the technologies, while 48.8% were not. The results in Figure 5.1E further show that most respondents (combined), 78.9%, had been using the ATs for one year, 45.1%, and 33.8% for two years. Surprisingly, some respondents have used ATs for four (4,2%) to five years (4,2%). Two significant sources of information are depicted as the university (42.3%) and friends (40.8%); see Figure 5.1F. This implies that the information about the disability unit could be diffusing mainly through informal means rather than formal ones, considering that an additional 16.9% get the information through other means, raising the grapevine source to 57.7% (friends and other means). Respondents were asked to indicate how difficult it was to get ATs; just above 50% confirmed that it was easy, while close to 44% indicated otherwise. The results in Figure 5.1G confirm that ATs were challenging to access from the unit, as indicated by more than 40% of the respondents who may have made attempts to access the devices and failed (40% is a significant portion to ignore, and this indicates an inherent problem within the unit). Lastly, results in Figure 5.1H show that the minority of respondents, 29.6%, were trained, while the majority, 70.4%, were confirmed not to have been trained in using the ATs.

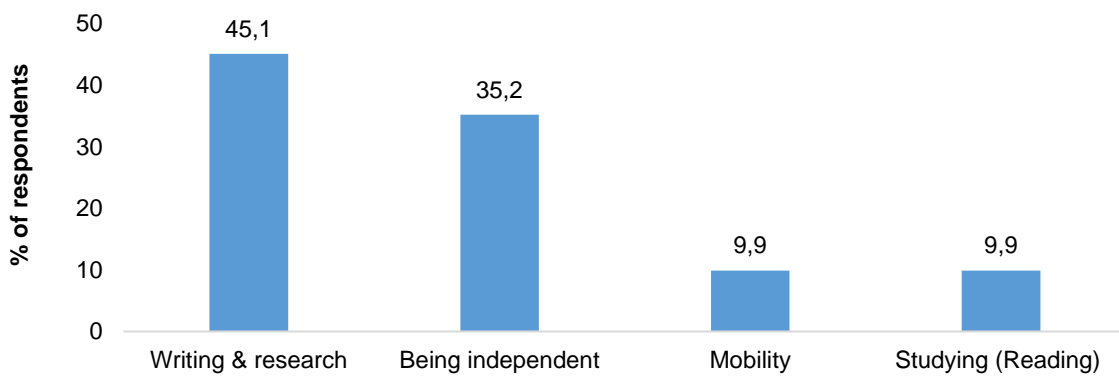
A Chi-square test of dependence between *training* and *easy-to-get ATs* was performed, and the results showed no significant association between the two variables as $p > 0.05$, as shown in Table 5.1.

Table 5. 1: Chi-square test of dependence between training and ease of getting ATs

Training on AT		Very Difficult	Difficult	Easy	Very easy	Total	Chi-Square	df	p-value
Trained	Count	2	7	12	0	21	1,692 ^a	3	0,639
	Expected Count	2,7	6,5	10,9	0,9	21,0			
	% within Q7 Training on AT	9,5%	33,3%	57,1%	0,0%	100,0%			
	% of Total	2,8%	9,9%	16,9%	0,0%	29,6%			
Not trained	Count	7	15	25	3	50			
	Expected Count	6,3	15,5	26,1	2,1	50,0			
	% within Q7 Training on AT	14,0%	30,0%	50,0%	6,0%	100,0%			
	% of Total	9,9%	21,1%	35,2%	4,2%	70,4%			
Total	Count	9	22	37	3	71			
	Expected Count	9,0	22,0	37,0	3,0	71,0			
	% within Q7 Training on AT	12,7%	31,0%	52,1%	4,2%	100,0%			
	% of Total	12,7%	31,0%	52,1%	4,2%	100,0%			

These results may suggest that access to ATs could not have been based on the training one received but on other factors considered at the disability unit.

The results for the type of assistance sought from the disability unit are depicted in Figure 5.2.



AT Assistance sought from disability unit

Figure 5. 2: AT Assistance sought by students

The results show that most of the students (80.3%) who visited the disability unit sought assistance for writing and research (45.1%) and being independent (35.2%). Respondents were asked to rate the frequency of their use of devices in the disabilities unit. Respondents were further asked to rate their frequency of use of the ATs found in the disability unit. The frequency of use of ATs was ranked on a Likert scale as shown: *Every day = 5 Three times a week = 4 Twice a week = 3 Once a week = 2 Once a fortnight = 1.*

The results in figure 5.2 show the distribution of the ratings on the frequency of use of ATs together with descriptive statistics, mean (M), and standard deviation (Std). A mean of 3.0 and above shows a high-frequency use of a device, between 2.0 and 3.0 moderate use, and below 2.0 weak use. Of the twenty possible ATs in the facilities, only five (Word prediction software, Electronic resources and books, Educational software, Visual search engines, and Electronic spell checkers) had a high frequency of use every day to twice a week by most respondents and means above 3.0. This low-frequency use of ATs by respondents indicates underlying challenges in the disability unit.

Table 5. 2: Ratings on the frequency of use of ATs in the disability unit

ATs used	Frequency of use of ATs in the disability facility					Total	Mean	Std Dev
	Every day =5 n (%)	Three times a week = 4 n (%)	Twice a = 3 n (%)	Once a week = 2 n (%)	Once a fortnight = 1 n (%)			
Word prediction software	12 (16.9)	19 (26.8)	20 (28.2)	6 (8.5)	14 (19.7)	71	3.3	1.5
Electronic resources and books	19 (26.8)	9 (12.7)	24 (33.8)	2 (2.8)	17 (23.9)	71	3.3	1.6
Educational software	15 (21.1)	16 (22.5)	16 (22.5)	11 (15.5)	13 (18.3)	71	3.1	1.4
Visual search engines	6 (8.5)	14 (19.7)	19 (26.8)	11 (15.5)	21 (29.6)	71	3.0	1.6
Electronic spell checkers	12 (16.9)	5 (7)	21 (29.6)	14 (19.7)	19 (26.8)	71	3.0	1.6
Alternative keyboards	15 (21.1)	16 (22.5)	7 (9.9)	12 (16.9)	21 (29.6)	71	2.9	1.6
iPads and tablets	17 (23.9)	10 (14.1)	10 (14.1)	12 (16.9)	22 (31)	71	2.8	1.6
Adjustable monitor arms	6 (8.5)	22 (31)	14 (19.7)	7 (9.9)	22 (31)	71	2.8	1.4
Literacy specific software	8 (11.3)	14 (19.7)	12 (16.9)	12 (16.9)	25 (35.2)	71	2.7	1.6
Visual aids, graphic and drawing tools	5 (7)	15 (21.1)	9 (12.7)	15 (21.1)	27 (38)	71	2.4	1.4
Smart reader	8 (11.3)	11 (15.5)	7 (9.9)	14 (19.7)	31 (43.7)	71	2.3	1.5
Use Text-to-speech	10 (14.1)	9 (12.7)	7 (9.9)	11 (15.5)	34 (47.9)	71	2.3	1.5
Voice recognition	1 (1.4)	8 (11.3)	12 (16.9)	18 (25.4)	32 (45.1)	71	2.3	1.5
Digital recorders	3 (4.2)	12 (16.9)	9 (12.7)	11 (15.5)	36 (50.7)	71	2.3	1.5
Desktop magnifier	0 (0)	19 (26.8)	8 (11.3)	17 (23.9)	27 (38)	71	2.3	1.2
Rubby HD	4 (5.6)	16 (22.5)	4 (5.6)	10 (14.1)	37 (52.1)	71	2.2	1.4
A3 scanners	3 (4.2)	9 (12.7)	5 (7)	15 (21.1)	39 (54.9)	71	1.9	1.2
Talking Scientific Calculator	1 (1.4)	13 (18.3)	3 (4.2)	13 (18.3)	41 (57.7)	71	1.9	1.2
Reading pens	3 (4.2)	8 (11.3)	3 (4.2)	12 (16.9)	45 (63.4)	71	1.8	1.2
Braille Sense	0 (0)	6 (8.5)	1 (1.4)	8 (11.3)	56 (78.9)	71	1.4	1.0

After presenting and interpreting demographic information, attention is shifted to the data collected to answer the research questions. The results were presented and assessed following the study's objectives.

Respondents were asked to indicate the types of disabilities they have that required the aid of ATs in learning. Results are shown in Table 5.3.

Table 5. 3: Distribution of respondents by type of disabilities

Type of disability	Frequency	Percent
Physical disabled	32	45.1
Chronic Illness	17	23.9
Partially sightedness	10	14.1
Partially blind	7	9.9
Hearing impairment	3	4.2
Multiple disabilities	2	2.8
Total	71	100.0

The results showed that physical disability was most prevalent among respondents, as indicated by 32 (45.1%), followed by chronic illnesses among 17 (23.9%) respondents. Hearing impairment and multiple disabilities were the least prevalent, as less than 6% of the respondents suffered from these two. The results confirm that more ATs for students living with physical disabilities, chronic illness and partially sighted students are required in the disability unit as well as for integration purposes.

5.2.1.2 SECTION B: What are the socio-technical challenges faced by students with disabilities in historically disadvantaged universities in South Africa?

Concerning challenges faced by students with disabilities, respondents were asked to rate on a 3-point Likert scale the seriousness of an issue as a challenge in using ATs. The results are shown in Table 5.4.

Table 5.4: Challenges to the use of ATs by students with disabilities

Challenges to use ATs	Likelihood of a challenge to be serious			Total	Mean	Std. Dev
	Very serious = 3 n (%)	Not serious = 2 n (%)	Not sure = 1 n (%)			
Inadequate assessment and planning processes	39 (54.9)	18 (25.4)	14 (19.7)	71	2.4	0.8
Insufficient funding	41 (57.7)	13 (18.3)	17 (23.9)	71	2.3	0.8
Difficulties procuring and managing equipment	38 (53.5)	16 (22.5)	17 (23.9)	71	2.3	0.8
Time constraints	49 (69)	13 (18.3)	9 (12.7)	71	2.3	0.7
Lack of appropriate staff training and support	47 (66.2)	21 (29.6)	3 (4.2)	71	2.2	0.8
Negative staff attitudes	20 (28.2)	30 (42.3)	21 (29.6)	71	2.0	0.8

For results in Table 5.4 a mean greater than 2.0 shows the challenge was serious, while a mean of 2.0 and below shows that the challenge should not be considered serious. The results show that five factors measured could be considered serious, as indicated by the majority of respondents, at least 54%, and Mean \pm **Standard deviation Std (2.2 \pm 0.8)**. Negative staff attitudes are the exception.

Solutions to challenges

Respondents were asked to indicate the solutions to challenges faced by students with disabilities. Results are shown in Table 5.4.

Table 5. 5. Improvement to challenges

Improvement	Ranking on potential challenges (n =71)					Total	Mean	Std Dev
	Strongly Agree = 5	Agree = 4	Neutral = 3	Disagree = 2	Strongly Disagree = 1			
	n (%)	n (%)	n (%)	n (%)	n (%)			
Timely allocation of assistive devices is important	24 (33.8)	33 (46.5)	10 (14.1)	2 (2.8)	2 (2.8)	71	4.1	0.9
Training our lecturers on how to support students with disabilities is important	28 (39.4)	30 (42.3)	9 (12.7)	4 (5.6)	0 (0.0)	71	4.1	0.8
Continuous training and developing staff on teaching students with disabilities	25 (35.2)	30 (42.3)	12 (16.9)	4 (5.6)	0 (0.0)	71	4.1	0.8
Improving the process of buying assistive devices by involving students with disabilities	23 (32.4)	29 (40.8)	15 (21.1)	4 (5.6)	0 (0.0)	71	4.0	0.9
All staff members should be trained to work with students living with disabilities	19 (26.8)	33 (46.5)	17 (23.9)	2 (2.8)	0 (0.0)	71	4.0	0.8
Lecturers must be trained on how to teach students with disabilities	18 (25.4)	35 (49.3)	16 (22.5)	2 (2.8)	0 (0.0)	71	4.0	0.8
Lecturers should allow students with disabilities to study at their own pace while monitoring them	27 (38.0)	15 (21.1)	13 (18.3)	10 (14.1)	6 (8.5)	71	3.9	0.9
Lecturers should understand special needs and treat students with disabilities with care and love	10 (14.1)	28 (39.4)	16 (22.5)	13 (18.3)	4 (5.6)	71	3.8	1.1
Lecturers should not overload students with disabilities with assignments	26 (36.6)	28 (39.4)	15 (21.1)	2 (2.8)	0 (0.0)	71	3.8	1.1
All university buildings are easily accessible to students with disabilities	14 (19.7)	23 (32.4)	15 (21.1)	10 (14.1)	9 (12.7)	71	3.3	1.3
I received appropriate lecturer support on AT to meet my learning needs	15 (21.1)	26 (36.6)	7 (9.9)	15 (21.1)	8 (11.3)	71	2.1	1.4
Continuous training in AT use is provided to students with disabilities in the institution	10 (14.1)	19 (26.8)	9 (12.7)	20 (28.2)	13 (18.3)	71	2.2	1.2
Students with disabilities have adequate time to use ATs for learning purposes	13 (18.3)	20 (28.2)	12 (16.9)	23 (32.4)	3 (4.2)	71	2.1	1.1
There are enough special mentors and tutors to assist in the use of ATs for learning purposes	5 (7.0)	14 (19.7)	14 (19.7)	33 (46.5)	5 (7.0)	71	2.1	1.2
Labs with AT operation times are suitably arranged to suit the needs of students with disabilities	6 (8.5)	14 (19.7)	15 (21.1)	16 (22.5)	20 (28.2)	71	2.4	1.3

The results in Table 5.5 show the ranking of a potential challenge based on a 5-point Likert scale with five as Strongly agree and one as strongly disagree, arranged according to the mean scores (M). A mean score of 3.8 and above indicates that respondents agreed that the solution was viable to the challenge faced by students with disabilities. On the other hand, the mean score of less than 2.5 indicated that respondents disagreed with the idea as a challenge to the students with disabilities concerning the disability unit and support given. Rather, a mean score of less than 2.5 indicated that the issue remains a challenge that must be addressed by doing the opposite of what is currently happening.

The first six solutions in Table 5.5 were confirmed as viable solutions by the most respondents ($\geq 59\%$) in all cases. It implies that respondents could have observed that the facility was lacking in providing simple requirements to meet students' needs. The last five statements were ranked low because they expressed what was against the respondents' expectations in meeting the needs of the students living with disabilities. For example, there was poor lecturer support, no proper training provided to students, inadequate time given to students, a shortage of special mentors to assist students, and poor programming of times to access the labs (all with $M < 2.5$). The solutions to these challenges were to address the challenges experienced and implement some suggested solutions in Table 5.5.

5.2.1.3 SECTION C: Technical skills.

The technical challenges were assessed using six statements in which respondents were asked to rate themselves the extent to which each statement their skills compared on a 5-point Likert scale. The results for each set of technical skills are presented as frequency charts in Figures 5.3 to 5.8.

The extent of understanding of the characteristics of devices used in the disability unit was considered important, and respondents were asked to indicate the extent to which they were familiar with the characteristics. Figure 5.3 shows the results for rankings made by respondents.

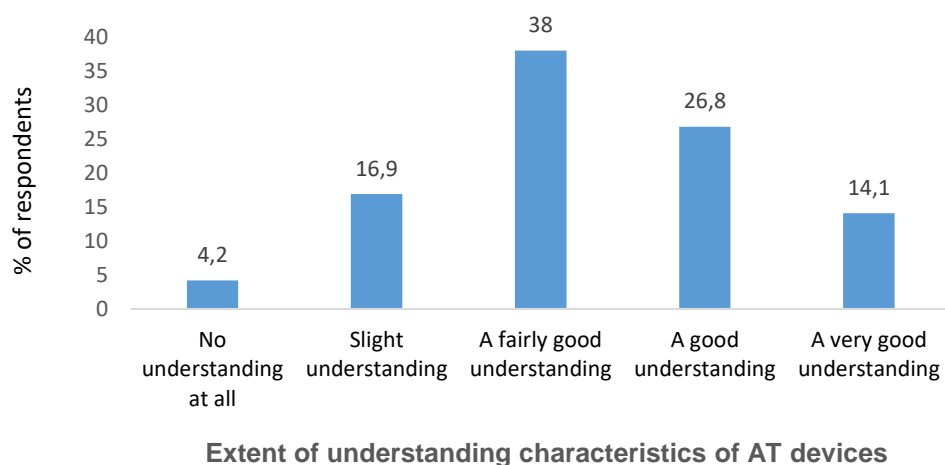


Figure 5. 3: Extent of understanding of characteristics of AT devices

According to the results in Figure 5.3, only a minority of respondents, 4.2%, indicated that they did not understand anything about the characteristics of the devices used in the disability unit. The extent to which respondents understood the characteristics of the device ranged from good to very good, as indicated by close to 71% of the respondents who affirmed that. The mean score of 3.4 confirmed that understanding of the characteristics of AT among the respondents was fair. Therefore, most students living with disabilities had a fair understanding of the characteristics of the ATs and needed some training to gain a better understanding.

The extent of logging into a device and accessing online content: Students using the ATs are expected to be able to use devices to access online learning materials, and they have to log in, hence the importance of assessing such technical skills. This was accomplished by

asking respondents about the extent of logging into a device and accessing internet content. Figure 5.4 displays the results on the distribution of respondents.

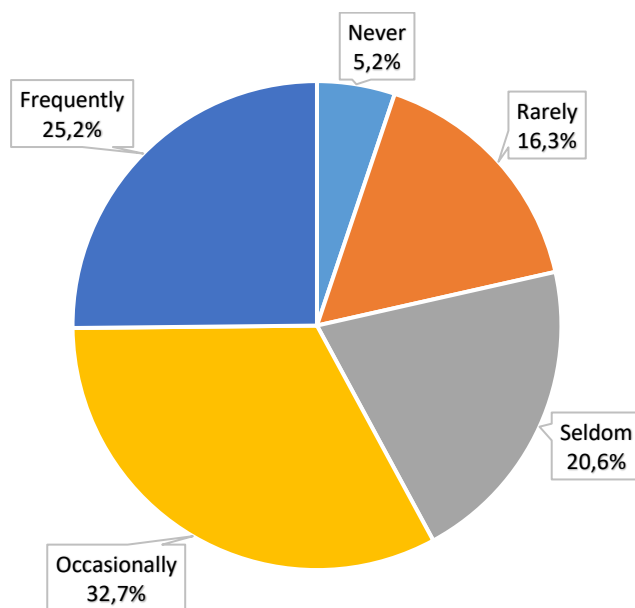


Figure 5. 4: Extent of logging into a device and access online content

The results in Figure 5.4 confirm that only 25.2% of the respondents frequently access online content that requires students to log in. Most students, 53.3%, erratically used devices to access online content, and 5.2% never accessed online content using devices. Generally, a mean score of 3.4 and Std of 1.3 confirm that students seldom access online content and this could be due to various factors that need to be addressed using the proper intervention methods.

The **ability to navigate online resources** is important for students living with disabilities these days. Using a 5-point Likert scale, respondents ranked their extent of losing orientation when navigating online, and results are shown in Figure 5.5. The results show that most respondents (74%) had issues navigating online resources as they quickly got disoriented. Of concern are the 23.9% of the respondents who were completely disoriented when navigating online material. This means that most students cannot navigate online resources without getting lost. This indicates a mean score of 2.7 and Std 1.2, showing the poor ability to sustain a consistent balance in online resources. It is also a sign of significant discrepancies among students living with disabilities. This is also reflected in the previous section, where most respondents indicated that they had not been trained to use facilities.

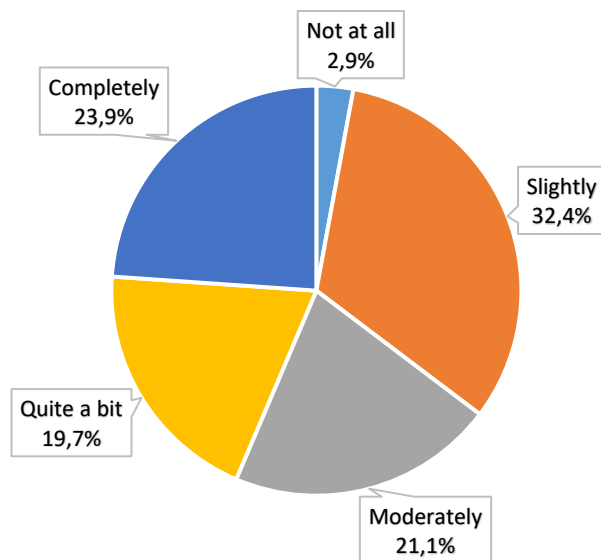


Figure 5. 5: Extent of losing orientation when navigating online

For the extent of formulating a statement for searching information, results are shown in Figure 5.6.

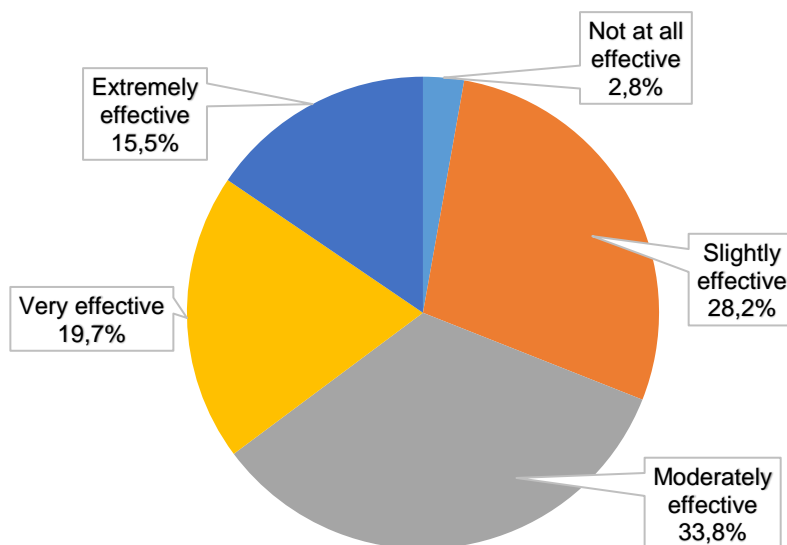


Figure 5. 6: Extent of formulating a statement for searching information

The results show that less than 40% of the respondents indicated being capable of formulating questions when searching for information on the Internet. In comparison, close to 52% indicated being ineffective in this area. The results confirm that a problem did exist, and an urgent solution was needed to assist students in searching the Internet when using ATs.

The ability to use the internet to access online information is highly recommended for students pursuing academic degrees. Respondents are asked to rate **the extent of Internet use in finding and retrieving information from various online sources**, and the results are in Figure 5.7.

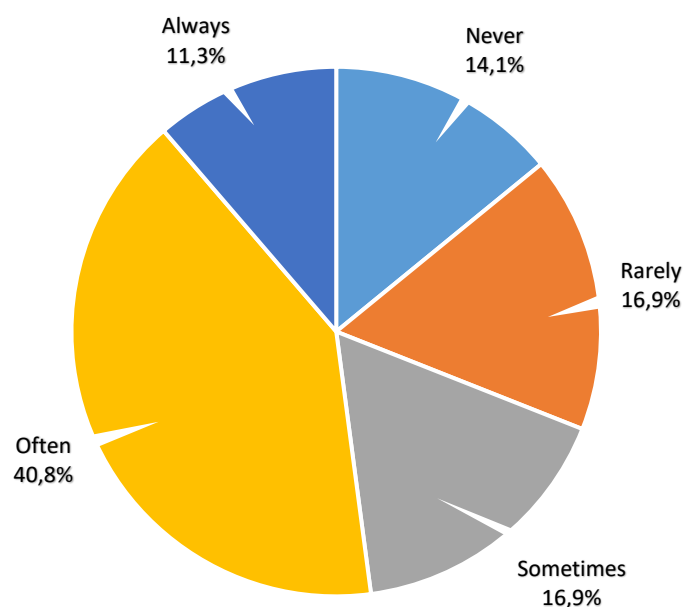


Figure 5. 7: Extent of Internet use to find and retrieve information from various online sources

According to these results, less than 12% of the respondents showed that they always used the Internet to locate and retrieve information from various online sources. A considerable number, 40.8%, indicated that they often used the internet, while 16.9% used it sometimes, and the rest hardly used it. This indicates that the use of the Internet by students with disabilities requires redress to improve these students' abilities to benefit from ATs that depend on the Internet.

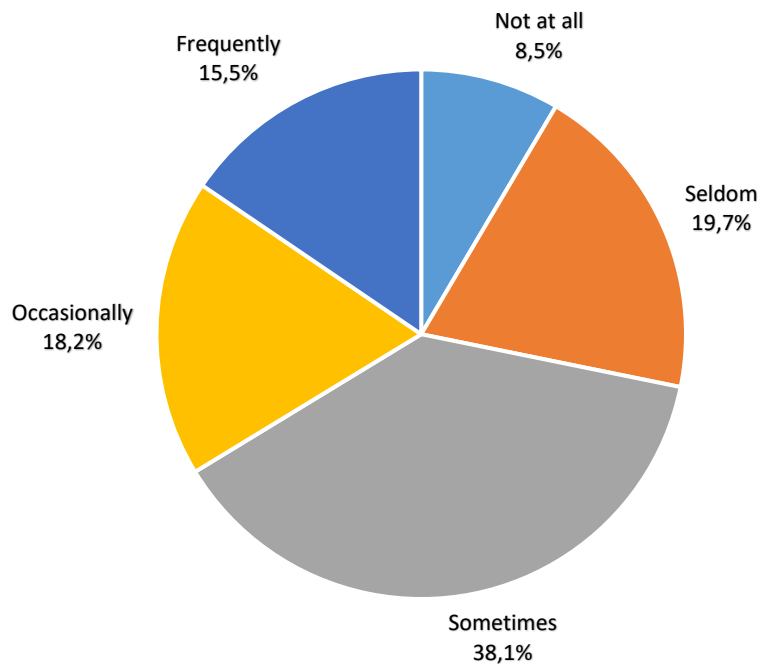


Figure 5. 8: Extent of using the Internet to organise information so that you can locate it later

The results show that 15.5% of the respondents confirmed that they frequently used the Internet to organise information for future use, and 18.2% occasionally did that. Most respondents indicated that they sometimes or seldom utilised the Internet to organise information to use it for some time. Very few respondents, 8.5%, indicated not using the internet for information organisation.

Investigating the appropriateness of ATs being used by students living with disabilities was important for the study. Respondents were asked to rate ATs' appropriateness in completing given academic tasks on a 5-point Likert (Very appropriate = 5 to very inappropriate = 1). The results are shown in Figure 5.9.

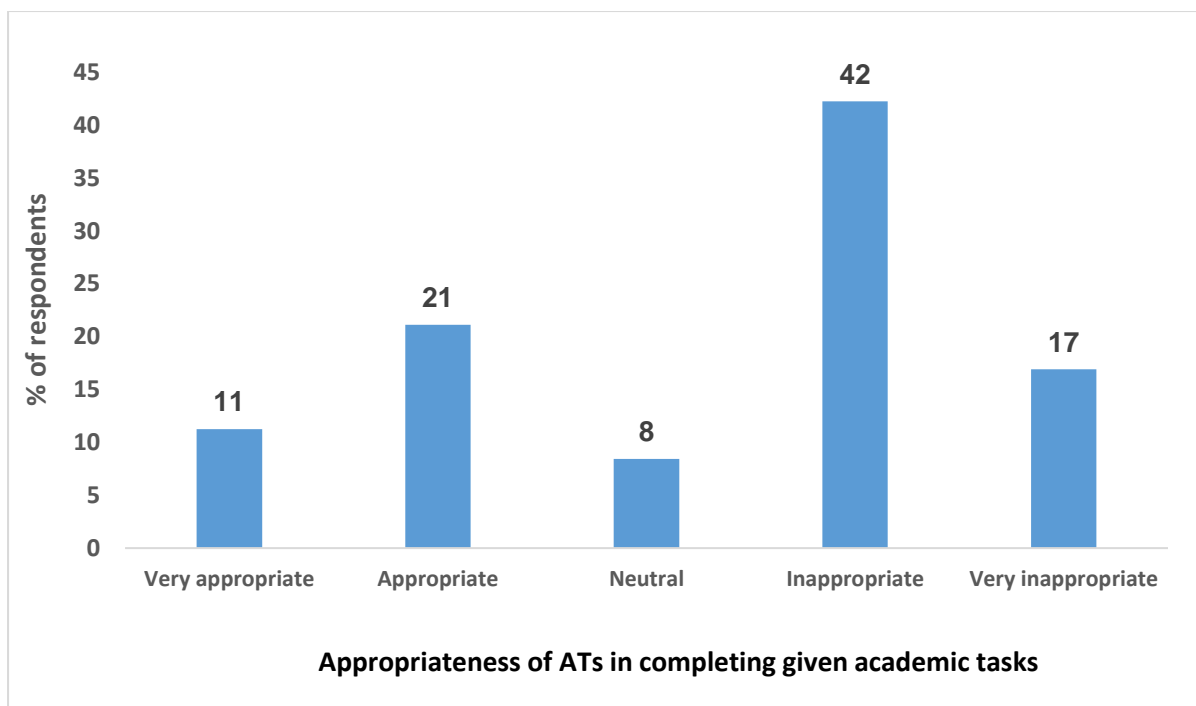


Figure 5. 9: Appropriateness ATs provided to complete academic tasks

The results in Figure 5.9 show that less than 35% of the respondents believed that the ATs they used were appropriate academic activities given, while most of the respondents, 59%, indicated otherwise. These results show that it would be challenging to integrate appropriate ATs into inclusive education. Therefore, much should be done to procure appropriate ATs.

5.2.1.4 SECTION D: Requirements for Framework for integrating AT in inclusive education

Respondents were asked to rate The possible criteria for the framework for integrating ATs in inclusive education at the university, which were evaluated on a 5-point Likert scale (5 - strongly agree to 1 - strongly disagree). The ratings are in Table 5.6.

Table 5. 6: Ratings on potential requirements for the framework

Factors to consider as requirements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Moderating						
Identifying disabilities among students	29 (41.3)	19 (26.1)	14 (19.6)	6 (8.7)	3 (4.3)	71 (100)
Matching students' needs to disability before purchasing or allocating existing ATs	34 (47.8)	12 (17.4)	12 (17.4)	8 (10.9)	5 (6.5)	71 (100)
Procurement strategies						
Putting in place policies for AT procurement	37 (52.2)	20 (28.3)	5 (6.5)	3 (4.3)	6 (8.7)	71 (100)
Assistive technologies procurement processes must be inclusive	36 (50.0)	19 (26.1)	8 (10.9)	5 (6.5)	5 (6.5)	71 (100)
Involving students with disabilities in the selection of ATs before procuring	34 (47.8)	22 (30.5)	5 (6.5)	5 (6.5)	6 (8.7)	71 (100)
Free communication channels between students and service providers about the ATs	40 (56.5)	12 (17.4)	8 (10.9)	5 (6.5)	6 (8.7)	71 (100)
The procurement committee should continuously hold consultative with students and lecturers on the acquired ATs	31 (43.5)	23 (32.6)	6 (8.7)	5 (6.5)	6 (8.7)	71 (100)
Consistent taking stoke of ATs in good working conditions before purchasing a replacement	19 (26.3)	29 (41.3)	7 (9.5)	9 (13.1)	7 (9.8)	71 (100)
Reducing over-reliance on service providers when procuring ATs	20 (28.3)	25 (34.8)	14 (19.5)	5 (6.5)	8 (10.9)	71 (100)
Involving parents/guardians of students with disabilities in the procurement of ATs	28 (39.1)	11 (15.3)	17 (23.9)	11 (15.2)	5 (6.5)	71 (100)
Training strategies						
Having policies on the training of teaching staff on the use/integration of ATs in inclusive education	36 (50.0)	12 (17.4)	14 (19.6)	3 (4.3)	6 (8.7)	71 (100)

Factors to consider as requirements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Having workshops on ATs with all support staff to raise awareness about the integration into inclusive education	39 (54.4)	19 (26.1)	5 (6.5)	3 (4.3)	6 (8.7)	71 (100)
Having inclusive training programs for students with disabilities and staff on matters about ATs	45 (63.0)	12 (17.4)	8 (10.9)	6 (8.7)	0 (0.0)	71 (100)
Training programs for educators and support staff should focus more on the integration of ATs in inclusive education rather than on technical issues	37 (52.2)	17 (23.9)	6 (8.7)	6 (8.7)	5 (6.5)	71 (100)
Funding						
Having a reliable funding mechanism to ensure equitable access to ATs for all students in inclusive classrooms	42 (58.7)	15 (21.8)	6 (8.7)	3 (4.3)	5 (6.5)	71 (100)
Sourcing for AT devices from potential donors	40 (56.5)	19 (26.1)	5 (6.6)	3 (4.3)	5 (6.5)	71 (100)
AT integration strategies						
Policy-driven student-centred AT integration	22 (30.4)	36 (50.0)	6 (8.8)	5 (6.5)	3 (4.3)	71 (100)
Stakeholders' collaboration for ATs integration in inclusive education	22 (30.4)	31 (43.6)	9 (13)	5 (6.5)	5 (6.5)	71 (100)

The results in Table 5.6 show factors respondents considered essential requirements to successfully integrate ATs in inclusive education. The requirements are briefly elucidated.

Moderating factors: The first requirement concerned moderating factors, namely identifying disabilities of students at the onset, confirmed by close to 68% of the respondents who agreed to the importance of this requirement, matching students' needs to disability before purchasing or allocating existing ATs, affirmed by approximately 66% of the respondents. By considering these two requirements, the university can save on expenditure by purchasing the appropriate ATs and avoiding buying ATs that students did not use. The possibility of students not using ATs is very high if this technology is inappropriate and does not match their needs. Integration is highly possible if the technology matches students' needs.

Procurement strategies: These have a more significant share in the requirements for AT integration, as indicated by eight critical factors considered. Most respondents (80.5%) strongly agreed/agreed that procurement policies for ATs should be implemented to regulate this process. These results imply that AT purchases are not regulated by specific policies, resulting in the acquisition of wrong devices that do not meet the needs of the students. Secondly, close to 77% of the respondents firmly confirmed the need for the AT procurement policies to be inclusive. If such policies existed, they must be made available to students and should cover a wide range of disabilities identified at the initial stages. This finding could be synchronised with a requirement for involving students with disabilities in selecting ATs for their needs, as indicated by close to 73% of the respondents. This implies that the university should deviate from the current practices in which they procure ATs depending on who convinces the committee by asking students to be involved in selecting the available ATs, especially if the providers come on campus to demonstrate how these technologies work and can be used. The results further show that close to 74% of the respondents were agreeable with the idea of accessible communication between service providers and students who used the device. Accessible communication would allow students who used the devices to provide the service providers with proper assessment and evaluation of the tools for further improvement. In the previous section, it was shown that poor student adaptation to ATs was not accounted for by the service providers, making things look normal at the expense of the students. Another critical requirement of the procurement strategies was the need for the committee to constantly hold consultative meetings with students and lecturers on how the devices were being used and the challenges faced by students. This was confirmed by 75% of the respondents. This would, in turn, inform the committee and the supporting staff about the actual functioning ATs or those that still meet students' needs. Approximately 67% of the

respondents strongly agreed/agreed that procurement of new ATs to replace the old ones should be done after the stock-taking of the current ones. According to 63% of the respondents, there was a need to reduce over-reliance on service providers when purchasing ATs as they tend to purchase whatever is being promoted by the provider. Lastly, 55% of respondents agreed that it must be a requirement to involve parents/guardians of students with disabilities in the acquisition of ATs. All these requirements were necessary for integrating ATs into inclusive education as they provided appropriate devices that matched students' requirements.

Training strategies: Many respondents rated four factors as strongly agreed/agreed upon. Close to 68% of the respondents strongly agreed/agreed with the need to implement policies for training teaching staff, students, and support staff on integrating ATs into inclusive education. This implied that the university did not have a proper AT integration policy, which was left to individual lecturers and students. Besides putting the right policies in place, 80% of the respondents affirm the need for workshops for lecturers and supporting staff to raise awareness of inclusive education and the role of ATs. This means that having policies in place and supporting their implementation was required at the university. This points to the need for lecturers and supporting staff to be knowledgeable about AT integration. Significantly, 80% of the respondents affirmed the need for proper training of students in AT use and integration in their learning rather than being convenient devices. Students did not find these relevant to their education without proper training on using ATs in academic activities. Training strategies are required to emphasise more inclusive education than technical aspects, an affirmation by 75% of the respondents. According to these results, training strategies fostering the integration of ATs in inclusive education at the university were urgently needed.

Funding: There were positive ratings on funding. According to 81% of the respondents, reliable funding for purchasing ATs for all students was identified as essential to the ultimate integration of ATs. This was possible because proper donations of ATs were made besides cash, which can be used for other purposes. Close to 83% of the respondents were convinced that if the university had a policy for funding ATs and how it could be used, students would spend more time using ATs for learning purposes that was happening.

AT integration strategies: Two AT integration strategies were rated as strongly agree/agree. Most respondents, 81%, stated that it must be a requirement for the university to have a student-centred AT integration, and this should be policy-driven to ensure uniform practices. According to the results, approximately 74% of the respondents agreed to the collaboration

between the university and its stakeholders on integrating ATs into inclusive education. These results show that the integration of ATs should be considered several factors and should be coordinated carefully with the ultimate goal of achieving a student-centred policy-based program to enable the university to monitor the process.

Correlation analysis on requirements for ATs Integration Framework

Using Spearman's correlation test, correlation analysis was conducted to determine which variables were significantly associated with each other and the size and direction of the association. There was no significant association between demographic data and other variables. Only results with significant correlation at $p < 0.05$ are reported, and the results are depicted in Table 5.7.

Table 5. 7: Correlational test results

Variables		Spearman correlation Coefficient (rho)	P-Value	N	Comment
Moderating factors	ATs procurement strategies	0.741**	0.000	71	Strong positive association
	ATs Integration training strategies	0.853**	0.000	71	Strong positive association
	ATs Funding Strategies	0.796**	0.001	71	Strong positive association
	AT Policies of Inclusivity	0.975**	0.000	71	Strong positive association
ATs procurement strategies	ATs Integration training strategies	0.544**	0.000	71	Moderate negative association
	ATs Funding Strategies	0.782**	0.000	71	Strong positive association
	AT Policies inclusivity	0.891**	0.000	71	Strong positive association
ATs Integration training strategies	ATs Funding Strategies	0.452**	0.000	71	Weak positive
	AT Policies inclusivity	0.730**	0.000	71	Strong positive association
ATs Funding Strategies	AT Policies inclusivity	0.905**	0.000	71	Strong positive association

The results in Table 5.7 show a solid and significant association between variables considered to be requirements for the framework for integrating ATs in inclusive education at the university, at $p < 0.05$. The other four requirements for ATs procurement strategies, integration training strategies, funding strategies, and policies of inclusivity were found to be directly associated with moderating factors, r between 0.741 and 0.975 at $p \leq 0.001$, an indication for the need to identify moderating factors among students living with disabilities before anything else. ATs integration training, funding, and inclusivity policies were further found to be significantly and positively associated with procurement strategies, with r between 0.544 and 0.891 at $p = 0.000$. This implies that these requirements depended on the procurement strategies implemented in the university, such that poor procurement strategies failed the other three requirements. The direct associations of the requirements were an indication that the integration of ATs in inclusive education required the university to consider many factors before and during the implementation process

5.2.4 Chi-square test of dependence

Chi-square tests were done to check the dependents of socio and technical challenges with selected demographic characteristics such as level of study, duration of use of ATs, training type of disability, and frequency of use of ATs — Table 5.8 The test of dependency of demographic variables and other variables yielded insignificant associations among the variables. The responses provided by respondents were dependent on factors other than demographic information. This implies that the demographic characteristics of respondents had an insignificant influence on how they viewed the socio and technical factors influencing the integration of ATs in inclusive education and the strategies that should be implemented to remedy the situation. These results are in synch with those from the correlational analysis presented above.

Table 5. 8: Chi-square test of dependence

	Ranking on (n =71)					total	Mean	Std. Dev
	5	4	3	2	1			
	n (%)	n (%)	n (%)	n (%)	n (%)			
Extent of understanding of characteristics of devices	19 (26.8)	10 (14.1)	27 (38)	12 (16.9)	3 (4.2)	71	3.4	1.2
Extent of logging into a device and accessing online content	17 (23.9)	22 (31)	14 (19.7)	11 (15.5)	7 (9.9)	71	3.4	1.3
Extent of losing orientation when navigating online	2 (2.8)	23 (32.4)	15 (21.1)	14 (19.7)	17 (23.9)	71	2.7	1.2
Extent of formulating a statement for searching information	11 (15.5)	14 (19.7)	24 (33.8)	20 (28.2)	2 (2.8)	71	3.2	1.1
Extent of Internet use to find and retrieve information from various online sources	29 (40.8)	8 (11.3)	12 (16.9)	12 (16.9)	10 (14.1)	71	3.5	1.5
Extent of using the Internet to organise information so that you can locate it later	11 (15.5)	13 (18.3)	27 (38)	14 (19.7)	6 (8.5)	71	3.1	1.2

5.4 SUMMARY

This chapter presented detailed results of quantitative data analysis and their interpretation. Results reported in the chapter were collected from 71 respondents (students living with disabilities) through an online questionnaire. The results were presented in four sections, starting with demographic information, which was important to understand the characteristics of the respondents and their use of ATs. The results show students' inconsistent and infrequent use of ATs, shortages of appropriate devices, and primarily a lack of training on how to use devices to support their integration. The study established and reported several socio-technical issues negatively affecting students' access to and use of ATs to aid their learning. Requirements for the framework for integrating ATs were tentatively established and summarised into five categories: moderating factors, AT procurement strategies, training strategies, funding strategies, and inclusivity policies. Statistical analysis involving descriptive, chi-square, and correlations supported findings. Means and standard deviations were utilised in descriptive statistics to demonstrate how representative the cited results were to the study's impaired student population. The Spearman correlations coefficient (ρ) results showed significant positive associations, ρ between 0541 and 0975 in the requirements variables at $p < 0.0001$, and insignificant association with all other variables.

The results of the second phase of the empirical study, the qualitative phase, are reported in Chapter 6 and were used to corroborate the quantitative findings in discussions in Chapter 7.

CHAPTER 6 QUALITATIVE DATA ANALYSIS, FINDINGS AND INTERPRETATION

6.1. INTRODUCTION

This chapter presents qualitative data findings from the interviews with five participants. The findings were a result of thematic data analysis. The findings are shown in a table as themes and subthemes.

6.2. JOB DESCRIPTION OF THE PARTICIPANTS AND DUTIES PERFORMED

The job descriptions of the participants are as in Table 6.1.

Table 6. 1: Job descriptions of participants and duties performed

Participant	Job description	Duties performed
Participant 1	Liaison officer	Distributing learning materials to students with disabilities
Participant 2	Registered Psychologist	Sourcing funding and learning material from funders for use by students with disabilities
Participant 3	Technologist	Prepares learning materials for students with disabilities
Participant 4	E-learning practitioner	Designing, implementing, and supporting various online learning activities such as developing digital content, training, facilitating online courses, and assisting lectures and students with online teaching technologies
Participant 5	Lecturer in Information Systems	Teaching students living with disabilities

Table 6.1 shows the job profiles of the participants who participated in the interview process. The results show that the participants were drawn from individuals with different job profiles and may have different perspectives about integrating ATs in inclusive education at the tertiary level. Participants perform essential duties in supporting students with disabilities in academic and social activities. The findings show that Participant 1 was involved in collecting and distributing learning materials to students with disabilities and ensuring that devices were procured. The given extract confirms the finding.

My duty is to make sure that students who need materials or learning materials from the library. In case they are going there and they cannot collect the book physical out of the library, I can intervene and go and collect that book on their behalf. Students who need gadgets for studying, I make sure that they are ordered and bought for them.

This finding indicates that an effort is made to assist students with materials and ATs for learning purposes. However, the integration part of it is not clearly expressed.

Participant 2 indicated that her/his main duty was to source funding and devices from organisations such as NSFAS, as indicated in the utterance:

My role here at the university is to support students with disabilities. I provide them with the following services career guidance and counselling. The one who started working with the Nsfas and requested for the devices. Within three months of my employment here, I requested funding for the students.

The duties of Participant 3 involved preparing learning materials and providing training in the use of ATs to students and teachers as well. This was made clear in the participant's attestation.

I just help student with the little things in preparing their learning materials, assisting them with training on adaptive technology, to invigilate them during weekends if they are writing tests or even there during the week. And sometimes I'm just making the recommendation, recommending the devices that they are using based on the disability, advocates for the disability unit on social media platforms.

Similar to the previous two participants, the attestation shows that support is given, but it is unclear how this translates to integrating ATs into inclusive education.

The university has skilled people in ATs and instructional technology, such as Participant 4, who indicated playing an essential role in the disability unit and the university. An extract from the interview with Participant 4 shows that the participant performs vital work in higher education:

Designing, implementing, and supporting various online learning activities, includes developing digital content, training, facilitating online courses, and assisting lecturers and students with online teaching technologies.

This attestation shows that the university has appropriate personnel in some areas to support the integration of ATs in inclusive education.

Finally, Participant 5 provided tuition to students living with disabilities.

I teach students living with disabilities Like last year, I had one student and I was assisting because I realised that she was having some issues such as handling the keyboard and moving the mouse.

The findings on the duties of participants show that support was given to students to pursue their academic courses at the university.

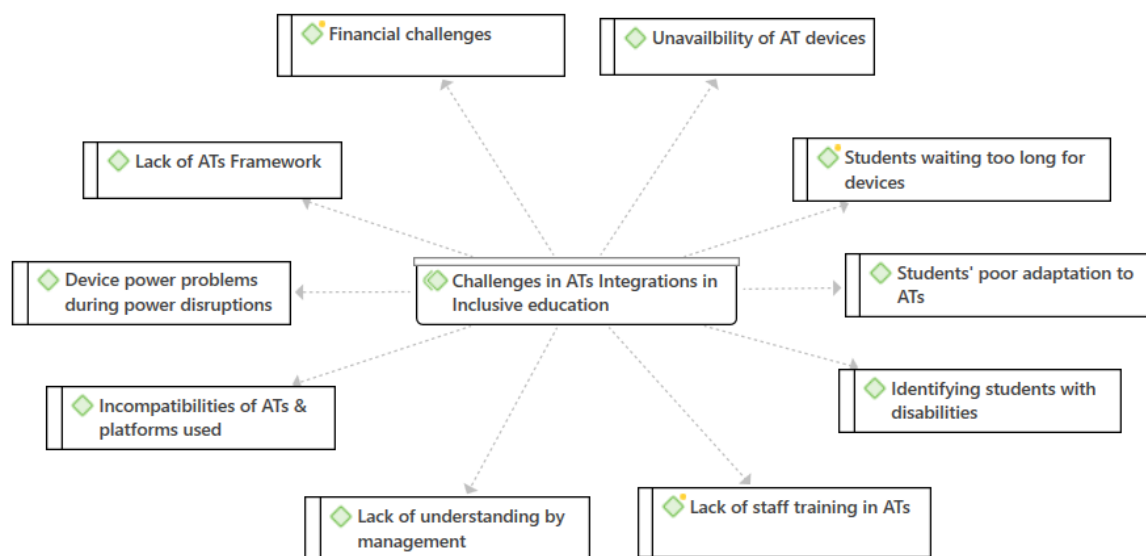
Themes and subthemes arising from the interviews are shown in Table 6.2.

Table 6. 2: Themes and subthemes

Themes	Subthemes
1. Challenges in integrating ATs into inclusive education	1.1. Financial challenges 1.2. Unavailability of AT devices 1.3. Students waiting too long for devices 1.4. Students 'poor adaptation to ATs 1.5. Identifying students with disabilities 1.6. Lack of staff training in ATs 1.7. Lack of understanding by management 1.8. Incompatibilities of ATs and platforms used 1.9. Device power problems during power disruptions 1.10. Lack of ATs Framework
2. Solutions to challenges	2.1. Training staff on disability issues 2.2. Sourcing funds for students' ATs 2.3. Timely purchasing of ATs 2.4. Understanding student's ATs needs 2.5. Training staff and students to use ATs 2.6. Collaborating with stakeholders on ATs 2.7. Being innovative with ATs 2.8. Designing Guidelines for Integrating ATs

6.3 THEME 1: CHALLENGES IN THE INTEGRATION OF ATs IN INCLUSIVE EDUCATION

This was the first theme that emanated from several ideas expressed by interviewees. Figure 6.1 shows the arrangements of the subthemes.



Name	Grounded	Density
○ ◆ Device power problems during power disruptions	1	1
○ ◆ Financial challenges	5	5
○ ◆ Identifying students with disabilities	1	2
○ ◆ Incompatibilities of ATs & platforms used	1	1
○ ◆ Lack of ATs Framework	5	6
○ ◆ Lack of staff training in ATs	2	3
○ ◆ Lack of understanding by management	1	4
○ ◆ Students waiting too long for devices	2	4
○ ◆ Students' poor adaptation to ATs	4	1
○ ◆ Unavailability of AT devices	1	4

Figure 6. 1: Theme 1 and its subthemes

source: challenges in the integration of ats in inclusive education atlas.ti

6.3.1 Subtheme 1: Financial challenges

As mentioned by all five participants, the financial challenges of procuring ATs emerged as the most prominent challenge. All participants indicated that delayed funding, which is always inadequate, resulted in delayed procurement or acquiring very few devices. The attestations by Participants 1 and 2 confirm this finding. For example, Participant 1 said,

I think poor financial resources or limited funding is always an obstacle to purchasing expensive technology which is difficult to find around this place.

This attestation shows that besides poor funding for ATs, the devices are very expensive, implying that only a few can be bought and that they are still insufficient for the students who need assistance in their academic activities. Reiterating the same challenge, Participant 2

observed that those students funded by NSFAS could not use the funds for this purpose as there was too little. Moreover, the devices were bought according to students' needs, a challenge that the funding from NSFAS could not address.

The extract from the interview with Participant 2 alluded to this finding,

The challenge is always when we do not have enough funding for some students because you find that when we purchase devices, we purchase them according to the student's needs. Some students require very specialised devices, which are also expensive, and students may not qualify for funding and the university takes time to approve the purchases. so it means that we have to purchase the devices maybe for that particular student, and it's a challenge because we have to go through procurement services and if the student doesn't have funding it's a challenge too to purchase for the students in himself or herself because as the university, if we're using the university a cover was purchased for the unit work for the students.

This attestation emphasises how the lack of finance from the university and potential funders affects the procurement of devices needed by students. This subsequently affects the integration of ATs in inclusive education. Furthermore, Participant 2 indicated that some students living with disabilities were not entitled to bursaries or funding and were expected to buy the devices for themselves.

However, some students are supposed to purchase devices for themselves because they use these devices if things are outside the university. So, the challenge is the funding for the individual students if they do not have.

This attestation shows that students without funding are in a worse situation than those with funding and can hardly buy expensive devices needed to support their academic activities. As long as funding remains problematic, the acquisition of ATs will be stalled, affecting the integration of the devices in inclusive education. Lack of funding leads to diminished procurement of the devices and an overall lack of ATs for integration purposes.

6.3.2 Subtheme 2: Shortage of ATs for integration purposes

Although there are ATs in the disability unit, they seem to be used by students who need urgent support and who need it in a limited time. Beyond this, ATs are adequate for use outside the disability unit because they are inadequate and are tailored to individual student's needs (Participants 2, 3, and 4). In most cases, such devices are used by students, making it difficult for lecturers who may want to use them in class. Says Participant 1.

I do not know if there is such; it's a matter of a student getting registered and coming to the department, then we borrow the student a device, and then he brings it when it is done when he or she is done. That's all.

This situation is attributed to the lack of a framework to direct the use and integration of ATs in inclusive education in the institution. Participant 2 alludes to this,

The university has no framework to govern AT integration or use of ATs. Students do whatever they want when they borrow ATs.

According to Participant 3, ATs for teaching purposes are scarce because of procurement issues, and those available are inadequate or do not address students' challenges. The participant said,

I think we have a serious problem with lecturers and students using the ATs in supporting integration purposes because there are few such devices, and some are appropriate for the lessons that they may be used. Students have various disabilities, and they use different ATs at different times. In some cases, the devices may be out of reach to lecturers.

It is apparent that without adequate and appropriate ATs, it is challenging to integrate the technologies into inclusive education.

6.3.3 Subtheme 3: Students waiting too long for devices

This finding emanated from utterances by Participants 1 and 5. According to these participants, the procurement of devices was a long process, sometimes lasting for three to six months, and by then, students could have completed a semester without essential ATs. For example, Participant 1 said,

The device must be purchased, but it might take a lot of time as the procurement process could be delayed. ... As follows, you know students, sometimes they wait for a long, long time for them to get their gadgets.

This is evidence that even if the money to purchase a specific device was available, procurement delays, which are always beyond those in the disability unit and lecturer's control, could always occur. Participant 5, a lecturer, expressed the same views and observed that some students missed important assignments due to long waits for devices ordered.

At times, I wonder what happens. One day it is about the shortage of money, the other day it is about the supplier or the order sitting in one of the offices in the university. We are students with special needs who require immediate attention when procuring devices. No one wants to be accountable. It is all long waits. Students yawn and yawn, they come to my office and end up referring them to the unit to find themselves. Some explanations do not convince at all.

With such a scenario, it is challenging for lecturers and students to integrate ATs into inclusive education. The concerned students always follow the same curriculum as normal students but are disadvantaged.

6.3.4 Subtheme 4: Students' Poor Adaptation to ATs

The delays in acquiring and delivering ATs result in students missing out on learning how to use the technologies. According to Participants 3 and 5, most students with disabilities find it challenging to adapt to the ATs and tend to continue with the way they used to learn, which is a disadvantage for them. Extracts from Participant 3 allude to integration setbacks due to poor adaptation to ATs.

At times, these students order devices that they want use even if you put them through the training. They tell you that they cannot adapt to them quickly... they struggle much with adaptation ...it seems that adaptation requires a lot of energy. So, it takes a long road so that there is learned to adapt to the technology that we have as the university.

Similarly, Participant 5 observed,

So sometimes, when the device comes, it gives a student the same problem; when they go to the class, it is very difficult for them to engage with their lecturer. ... As I indicated to you, this student was struggling with the practical part of using a computer. Do we have indicated that a computer is one of the assisting technologies, and sometimes it's tough for the student to adapt to their technology in classes or whatever.

These two utterances confirm the dilemma students and lecturers face in integrating ATs into inclusive education at the university.

6.3.5 Subtheme 5: Identifying students with disabilities

This finding emerged from the attestation by Participant 5, a lecturer who taught students with disabilities. Participant 5 indicated that it was sometimes difficult for lecturers to identify students with disabilities. The interview extract confirms this,

I do have challenges because for me to identify a student living with disabilities is not easy, I can only see the physical disabilities, so you may find those students instead of them to disclose with you directly. They have to go to DSU, and they find that only DSU is responsible for communicating with you. the problem is that by then you find that you have moved and the student you have left the student behind.

This implies that most of the time, the disability unit focuses much on physical disabilities, which may be easy to recognise compared to other disabilities that lecturers may be unable

to detect. In this circumstance, the integration of ATs may be undermined by hidden disabilities while much emphasis is on the physical one.

6.3.6 Subtheme 6: Lack of staff training in ATs

There was a finding concerning the staff training as a challenge to integrating ATs. Two individuals shared their perspectives on this matter. Firstly, it was Participant 3, who said,

It is challenging for us to find the lecturers so that we can train them on using ATs and inclusive education, but we are trying our level best in such a way that we can go far to educate our academics.

And Participant 4 who said,

It has been an annual problem that lecturing staff do not come forward for proper training in ATs. There is limited awareness and training among faculty and staff because they hesitate and only come when there is a big problem. At times, it was too late to get any help from the students.

These two extracts show the precarious situation at the university being studied concerning integrating ATs into inclusive education. This dilemma may continue with most lecturers avoiding training using ATs for teaching purposes. There could be a reason why the lecturing staff is avoiding taking up the training in ATs.

6.3.7 Subtheme 7: Lack of understanding by management

It was worth noting that university management was critical in the integration of ATs, as asserted by Participant 2, apportioned blame. This extract indicates the extent to which Participant 2 apportioned blame to university management,

Then I had to explain, but it seems as if up until today they don't understand what we mean by human support or technology for special students. But even when it comes to the devices, it wasn't easy for me and the student to get that funding up until we had the meeting with the management, who saw no reason to buy the devices when there were computers in the university, Participant 2.

This assertion indicates a huge misconception among some of the managers in the university who think that computers, in general, can alleviate challenges faced by students with disabilities.

6.3.8 Subtheme 8: Device power problems during power disruptions

In cases where students and lecturers decide to integrate ATs inclusive education, particularly activities in the classroom, power challenges surface, as indicated by Participant 1.

This technology uses batteries, but electricity in loadshedding at time extends 2 hours, and batteries for devices with the student in class run out of power as the battery goes flat. I mean that devices cannot be used.

This assertion means there are no power backups during power cuts. This limits the integration of ATs during the load shedding.

6.3.9 Subtheme 9: Incompatibilities of ATs & platforms used

According to Participant 4, some students find it challenging to use the devices because of old software, which may not be compatible with the new technologies.

I think, in many cases, some devices cannot be used with new platforms because they crash every time. There is very little way to ensure that the technology is compatible with our existing learning platforms that students use.

This was the single incident where a participant referred to the importance of software and device compatibility. From this finding, it could be deduced that most staff in the unit and students are not familiar with software upgrades, and this can be a challenge when integrating ATs where a new platform is used.

6.3.10. Subtheme 10: Lack of framework

Lastly, the study found that the university disability unit did not have a framework to guide the use and integration of ATs (Participants 2, 3, and 5). Participant 3 indicated there was no framework as they relied on a document from the Department of Education meant for schools. Participant 2 was clear on the lack of a proper framework to guide the integration of ATs in inclusive education. Hence this utterance,

There is no framework here at the university. Unfortunately, we use this one they call White Paper 6 and also that one for the higher education policy for inclusive education, which is general. No one knows what software or devices should be acquired until a student pitches up with a problem. It would be better if a framework was available to guide the university on what should be done.

Similarly, Participant 3 expressed ideas, as shown in the interview attestation.

That is where it leads us to what kind of we can admit at the university level. So, it's not all disability that the university should accommodate. So that's where we look at the disability of the student then the Department of Education provided the codes to categorise disabilities so that we can follow those guides.

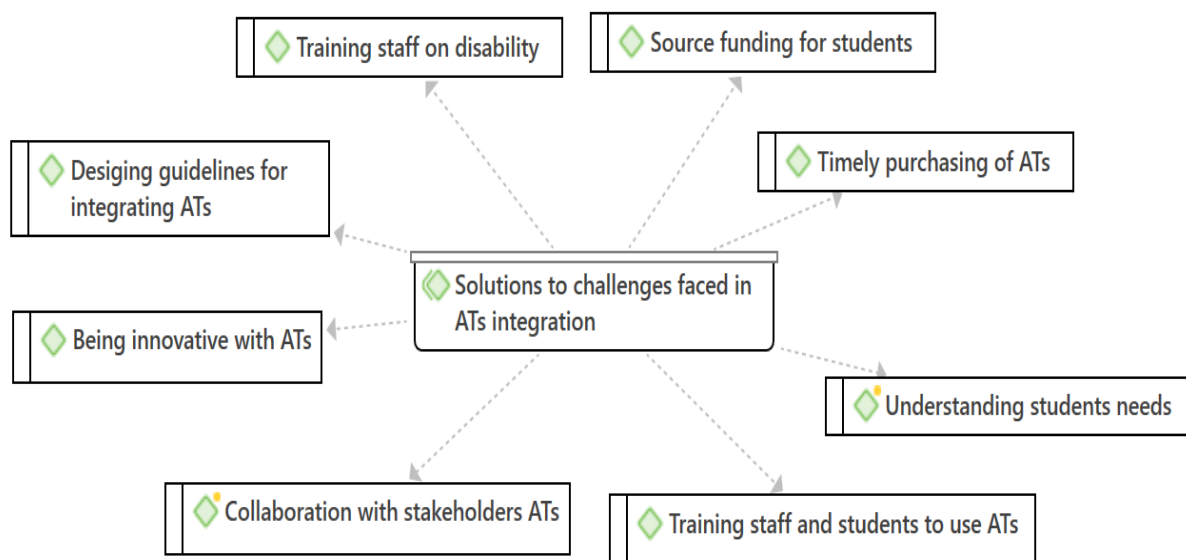
This confirms that the university did not have a framework for guiding the integration of ATs into inclusive education among the students. An extract from Participant 5 confirms this further,

I am not sure if there is anything that informs us how to deal with ATs, particularly for general lessons involving normal students. It seems that lecturers and even those in management do what they see working. No one knows what should be done.

This finding indicates that most challenges emanated from a lack of a framework to guide the use of ATs in the university.

6.4. THEME 2: SOLUTIONS TO CHALLENGES TO ATs INTEGRATIONS

For this theme, eight minor themes concerning the solutions to the challenges to the integrations of ATs were identified, as shown in Figure 6.2. A brief interpretation for each is given.



Name	Grounded	Density
○  Being innovative with ATs	 1	 2
○  Collaboration with stakeholders ATs	 2	 1
○  Designing guidelines for integrating ATs	 1	 1
○  Source funding for students	 1	 2
○  Timely purchasing of ATs	 4	 1
○  Training staff and students to use ATs	 4	 1
○  Training staff on disability	 1	 4
○  Understanding students needs	 4	 2

Figure 6. 2: Solutions to challenges in AT integration in inclusive education

source: solution to challenge in the integration of ATS in inclusive education atlas.ti

6.4.1. Subtheme 2.1: Training staff on disability issues

This idea was put forward by Participants 3 and 5, who voiced that teaching and other support staff were not acquainted with what happens in the disability unit and what important issues about students living with disabilities were supposed to be considered. The two participants

believed that staff training was necessary to integrate ATs in inclusive education successfully. The extracts provide the basis for this argument.

Both sides, the student and the staff members should be trained to know exactly how best they can assist students with disabilities or any person with disabilities. I believe when the university employs every staff member should go through the training because some of the staff members, don't know how to engage with the people with disabilities or the person with disabilities (Participant 3).

I am not sure if all lecturers and others are in a position to assist these students, let alone using ATs to teach them. What I think should be the solution is providing training to all lecturers where these students attend courses so that they are informed about how to assist them (Participant 5).

Implicitly, the participants think that receiving appropriate training concerning the integration of ATs was aided by having more knowledge about how the disability unit works and what important aspects of disability should be available to them.

6.4.2. Subtheme 2.2: Sourcing funds for students' ATs

According to Participant 2, the scarcity of ATs in the university can be alleviated by sourcing funding for students living with disabilities as soon as possible.

And I told them that yes. We are very much thankful you paid for the student, tuition, and accommodation and you are also giving the student the stipend, but it's like you have taken your money, then they throw it in the sea or the ocean because of that particular student was not having the right devices they student wasnot access learning material, you won't be able to access the classes and of which is our main objective. The most viable option is to source for funding from companies.

This opinion suggests that sourcing funding and getting as many ATs as possible resulted in the successful integration of the technology.

6.4.3. Subtheme 2.3: Timely purchasing of ATs

The notion was that delaying the purchase of ATs was a severe setback to integrating these technologies into inclusive education. Hence, the university has to buy these promptly. To achieve this, Participant 2 suggested that

If funds were available, I suggest that the buying of the devices must be done timely so that students get them on the opening of the university. There were times when I received funding from Vodacom for helping students with disabilities. The money was used to purchase devices for students because what I did, was I asked for the devices the funding for devices and the human support.

Participant 4 shared similar sentiments, saying:

The only way out of these challenges is to order devices beforehand and distribute them when students arrive. We are unsure if management sees any sense in speeding up this vital process. Some of the devices are complicated to use and they come very late.

According to Participant 5, buying devices on time was necessary because the university received suitable devices and had time to train users and lecturers. Consistent delays were very harmful to the teaching and learning processes.

And I think maybe somewhere, somehow if we have the right technologies to assist us or if the DSU department buys the right technologies on time, this will assist us to quickly identify such a situation and have the right technologies to assist those students, even if they are not in class, I think that one can go a long way for us assist students in using ATs for educational purposes.

These arguments are critical because technologies evolve constantly, and students need time to learn how to use them. Devices sometimes come without proper software and need configuration, which may be challenging.

6.4.4 Subtheme 2.4: Understanding students' needs for ATs

Three participants believed that the DSU must understand the students' needs regarding ATs so that the appropriate devices can be purchased. Training was also done with lecturers where affected students pursued their studies.

According to Participant 1,

In many cases, devices are wrongly used because they are given to students without understanding what students need. We assume that all students with disabilities need the same technology only to find out after that a lot of devices bought did not match the needs. Although all first-year students should get their devices right at the beginning of each semester some wasget the wrong devices.

Similar sentiments were expressed by Participant 2, who believed that disregarding students' needs when allocating ATs meant that when they ran into problems, they did not want to take responsibility. The extract is evidence of the observation,

When I talk about human support, it a strange thing that we forget individual needs and treat all students with a disability as having the type of disability. It would be good if we went down to students and asked them what they needed, then assessed them. It is not easy to get student devices when you do not know what the needs of each student are in terms of ATs.

Even Participant 5 seems to concur with the other two participants by saying

I try by all means to understand my student's needs in technology. Because I do teach a few students I try to understand their weaknesses and all challenges by asking questions in classes if those students who are having issues must come forward and I always try to be accessible to everyone in class. So by doing that I think it opens the door or it can open the door fully.

These extracts emphasise the importance of the management and those in the DSU to understand the needs of students leaving concerning the ATs.

6.4.5 Subtheme 2.5: Training staff and students to use ATs

Training staff and students to use ATs seems to be a popular suggestion from the interviews because most of the teachers were not trained in this area. According to Participant 2,

And if we don't have a trained staff, we still have a challenge because we find that students teach us with disabilities. We are still lacking the trained personnel and it's the challenge. So I think if maybe the department can train more people or more teachers on adaptive technology, it would assist.

Participant 3 argues that,

Maybe if they can train staff on the adapted technology it was assist. Unlike what we are doing currently, because we are saying that we are, we were shocked and then once and for all it means that we have workshopped them, but only for complacency, because they cannot use those devices.

This is expressed by Participant 4, who says,

There is a need to increase the standard of training of the academic staff so that it cannot be a problem between the students and the lecturers in the class.

This finding shows that ATs can only be integrated systematically by training lecturers and students.

6.4.6 Subtheme 2.6: Collaborating with stakeholders on ATs

Two participants expressed that the university could overcome the integration of ATs by working together with stakeholders who may have influences in several key areas. Participant 4 opined,

I believe that to improve the integration of ATs in inclusive education, ongoing collaboration and communication among stakeholders are essential This includes involving students with disabilities in the decision-making process, fostering a culture of accessibility and inclusion across the university, and staying informed about emerging technologies and best practices in the field of Assistive Technology and inclusive education.

This was affirmed by Participant 5, who said,

There is a need to create a clean relationship between lecturers, students and those who fund us, for example, even though I do not have these big classes on the first day. So maybe we have the DSU department working closer to the academic department. I think that one can be better because I think there is a gap. we are working hand in hand, but I think the current setup does not or is not helping the students because you find that as a lecturer you only rely on the DSU department to tell you that there's a student in your class with disabilities.

This finding is consistent with other initiatives that seek to be inclusive by bringing on board all important participants to integrate ATs.

6.4.7 Subtheme 2.7: Being Innovative with ATs

Only Participant 5 raised this idea because of being involved in teaching and using ATs to support teaching students with disabilities. The participant expressed,

We are always encouraged to come up with and methods come up with the interventions, interventions to assist students with disabilities. Normally these students can be at risk if appropriate measures are not taken to assist them on time, Participant 5. By using ATs, lecturers can assist these students in coping with their academic work.

This finding implies that the teaching staff needs a staff development program to assist them with new technology teaching methods. Using different technology, particularly software in ATs, can make these lecturers more resourceful and explore other ways of integrating ATs without compromising the quality of teaching.

6.4.8 Subtheme 2.8: Designing Guidelines for Integrating ATs

Two participants raised this issue because they believed there was nothing to guide the university in integrating ATs into the inclusive education curriculum. For example, Participant 4 said,

As it stands, we use the ATs sporadically because there are no guidelines or frameworks to inform us. This means that each lecturer does whatever they see fit and they are not bothered by anything. If we had properly laid down rules and guidelines, it would be better and easier to enforce this to all lecturers.

Participant 5 said,

Unlike other technologies which have models followed for their use in teaching, the ATs, seem to depend on individual students and lecturers. There is nothing regulating their use and how they can be used. The purchases are a guarded secret. We do not even know which students have such devices and how they use them. Without a policy for ATs in the university, the DSU struggles to have lecturers integrate these devices into inclusive education because it's not their duty to do so.

The importance of frameworks is emphasised and seems relevant, considering that many things are considered for effective integration. Consequently, a need for a framework arises if effective integration of ATs is to be realised in the university.

When quizzed on the aspects to be covered by the framework, only two participants had some ideas of what should be addressed. Participant 3 thought the framework should address AT acquisition and integration of ATs in education.

I would suggest that the framework has guidelines on what devices to buy and how to use them. When we have a framework, we are at an advantage of matching devices to students' needs as well as preparing teachers how to use the tools in their subject.

In the opinion of Participant 4, a framework was needed to address the broad challenges faced in the integration of ATs in teaching and learning, as well as issues faced by lecturers teaching students living with disabilities.

I am happy that you are addressing this issue. I have been wondering why the university should put in place measures to ensure a flawless system of providing students with learning technologies that have the appropriate technologies. I think a framework should look at who should qualify, how to train teachers to assist learners, and the support staff in the disability unit to source the right technologies.

These attestations indicate that participants know what should be done but lack knowledge of the framework that must be implemented.

6.5. SUMMARY

The chapter presented findings from qualitative data analysis in the form of themes and subthemes from five participants. The prominent themes were challenges faced in integrating ATs and the solutions that can be implemented. The lack of a proper framework resonated powerfully among the challenges and solutions among the participants.

CHAPTER 7 DISCUSSION OF FINDINGS

7.1. INTRODUCTION

Chapter 5 and 6 presented quantitative and qualitative data analysis and results. In this chapter, the researcher presents a detailed literature-controlled discussion of the study's findings. The discussion is conducted based on research questions guiding the study.

7.2. DISCUSSIONS OF FINDINGS

The main research question for this study was stated as follows: What were the main requirements for engineering modelling *for developing a framework to integrate AT in inclusive education at a disadvantaged South African University?*

7.2.1. Impact of Adaptive Assistive Technologies on enhancing inclusive education at a historically disadvantaged South African university

The impact of ATs was determined by assessing the benefits that students living with disabilities derived from these technologies. Findings from the Quantitative phase indicated that students were likely to benefit much from using ATs to support their education if the technologies were integrated ideally. The study found that most students who visited the disability unit did not find what they needed. However, they mainly benefited from writing and research (90.3%), studying using the equipment (70%) and being independent. Although there was a severe shortage of equipment and a lack of integration of ATs in inclusive education, the students felt that the benefits derived from the unit were considerably good in supporting their academic needs. Various outdated or malfunctioning ATs were available, and students tried to get the best out of these technologies, especially in completing assignments and during examinations. Responses from Participant 3, who was involved in assisting students at the disability unit, confirmed that AT use had a positive impact on students with serious writing problems, *“In most cases, students felt happy after using whatever devices were available in their assessment tasks including assignments, exams or tests”*. Even Participant 5, a lecturer, alluded to the fact that students who used the devices in the disability unit performed better than those who did not, *“I think the students benefited much from the little equipment in the unit. Those who avoided the unit still had hardships.”* According to Participant 4, the use of ATs changed the attitudes of some students who came from schools where the technology was scant.

I assist the students. I have seen the number swelling and more being happy with the assistance. Students are forthcoming for assistance, but the equipment and devices are overstretched. I have seen enthusiasm and eagerness to learn. If only more is done by the university to improve the equipment and upgrade the unit (Participant 4).

Another finding in this study was that 56% of the students with disabilities believed that the ATs made them somehow independent and that they could explore things by themselves. Some students indicated that ATs allowed them to realise their academic capabilities and were eager to learn. Integrating suitable ATs into inclusive education improves academic performance, independence, and possibilities for competitive employment (McNicholl, Casey, Desmond & Gallagher, 2021). Findings from other studies show that integration of ATs in inclusive education can promote educational, psychological, and social benefits among students living with disabilities (McNicholl, Casey, Desmond & Gallagher, 2021).

7.2.2 Which factors influence the integration of ATs in inclusive education at a historically disadvantaged South African university?

This question was investigated in the study's quantitative and qualitative phases. The study made several findings concerning factors affecting the proper integration of ATs at a selected rural university. Findings from the demographic information showed a strong willingness of students living with disabilities (70%) to use ATs to aid their education. However, their use was constrained by several factors which were investigated in this study.

7.2.2.1 Inadequate ATs in the disability unit

There were overwhelming responses about poorly resourced disability units at the university, implying a severe shortage of ATs for general use and those for specialised purposes. Integrating suitable ATs into inclusive education improves academic performance, independence, and possibilities for competitive employment (Vincent, Okeowo & Ariyo, 2024; Kimberly, 2023; Manase, 2023). At the university where the study was conducted, there was either a lack of ATs, improper ATs were purchased, or purchasing was delayed, resulting in students not having access to these devices. This trend was reported in the study by Vincent, Okeowo, and Ariyo (2024) that the use of ATs in Nigerian technical colleges was subdued by the shortage of appropriate ATs, which was due to the sourcing of wrong devices and software to the detriment of students. The study found that several socio-economic factors negatively influenced the integration of ATs in inclusive education at the university being focused on in

this study. Both quantitative and qualitative data revealed that students had various disabilities that require the support of diverse ATs, some easily available on the local markets, yet others were hard to find. Similarly, Vincent and Chiwandire (2019) argue that South Africa's higher education institutions cannot provide adequate ATs and other support services to students with disabilities due to the multifaceted challenges they face. According to Coleman *et al.* (2015), subdued integration of ATs in inclusive education is due to the lack of knowledge of suitable technology, which leads to buying the wrong ones that are inappropriate for use by students.

7.2.2.2 Lack of finances to purchase ATs.

This was compounded by the prices for the devices, especially specialised ones, that the university could not purchase due to financial constraints. For example, Participants 1 and 5 raised the issue of funding as the most challenging one as some students were not funded and were required to contribute towards purchasing the ATs. Due to a lack of finances and insufficient funding for students, the budget for the disability unit was either approved very late in the year or cut, with funds allocated to other needy areas (Participant 1). At times, some of the requirements for students surfaced when the budgets were already submitted, making it challenging to purchase the ATs outside the allocated funds. The findings are emphasised by Ndlovu (2021), who observes that the limited availability of specialised ATs in higher education for students with learning disabilities was due to poor funding for purchasing needed devices and appropriate software. A study by Harniss, Samant, and Matter (2015), which examined access to and service delivery of ATs among resource-constrained institutions, reports challenges in the availability of the technologies due to a lack of funds. According to the data from the interview with Participant 3, a student, at times, was asked to contribute to the purchase of the devices. This was corroborated by Participant 1, who indicated that students not being funded were asked to purchase the devices for their use. Therefore, poorly funded and unfunded students living with a disability find it difficult to access specialised ATs which need to be purchased. The famous #FeesMustFall-protests from 2015 in most South African universities manifested the seriousness of financial woes faced by students who fought increasing tuition fees and meagre government funding (Moloi, Makgoba & Miruka, 2017). On funding as a challenge, Participants 1 and 2 had this to say

I think poor financial resources or limited funding is always an obstacle to purchase of the expensive technology, which is difficult to find around this place (Participant 1);

and

The challenge is always when we do not have enough funding for some students because you wasfind that when we purchase devices, we purchase them according to the student's needs. Some students require very specialised devices which are also expensive, and students may not qualify for funding and the university takes time to approve the purchases. ... so it means that we have to purchase the devices maybe for that particular student and it's a challenge because we have to go this procurement services and if the student doesn't have funding, it's a challenge too to purchase for the students in himself or herself because as the university, if we're using the university, a cover was purchased for the unit work for the students (Participant 2).

Therefore, financial challenges are one of the significant factors affecting the acquisition of educational resources, including ATs, which are needed to enhance inclusive education in South African higher education (Machika & Johnson 2015). If not addressed, students from poor socioeconomic origins will be denied access to "digital capital that is instrumental in making them technologically apt" (Machika & Johnson, 2015; Manase, 2023). Although the government, through NSFAS, pays deserving students a book fund, it is insufficient to meet the exorbitant prices of specialised devices.

7.2.2.3 Delay in procurement of ATs due to bureaucracy at the university

As for the purchase of ATs at the university, the study found that close to 60% of the respondents were convinced that this process was unnecessarily prolonged by the procurement department, which has its challenges to deal with (Participants 1 & 4). Similar to some public institutions, universities are required to use the tender system in ordering devices, and this complex procurement process results in severe delays in the acquisition of ATs for students living with disabilities (Louw *et al.*, 2023). The procurement process could be long due to budget constraints, lack of knowledge about the needed ATs by the procurement committee, lack of suppliers, or shortages of the devices (Participant 2; Louw *et al.*, 2023). The issue of AT procurement has been discussed at a global level and was found to be obscured by many factors, resulting in wrong purchases of inferior technologies unsuitable for use in specific environments (European Parliamentary Research Service (EPRS) & Scientific Foresight Unit (STOA), 2018). To improve access to ATs, EPRS and STOA (2018) suggest enhancing transparency in the procurement process by involving knowledgeable people who can advise on the appropriate technology to acquire. Furthermore, the procurement of ATs must introduce obligations for the public institutions to put technical specifications that must

be considered accessibility criteria to meet the needs of people with disabilities or inclusive design for all users. These findings point to a lack of coordinated efforts by various departments in the university on research, use, and policy response to the access and procurement of ATs, leaving this to chance. Visagiei, Scheffleri, Seymourii, and Mji (2020) observe that the allocation of ATs and assistive products availability in South Africa was guided by the knowledge and passion of individual service providers and advocacy groups of particular products at the expense of other products and the needs of the users. This scenario could lead to providing the wrong ATs to universities because service providers can easily convince the procurement committee with minimal knowledge of the ATs needed by students with disabilities.

7.2.2.4. Difficulties procuring and managing equipment

A study by Fourie, D., & Malan, C. (2020). found that influential officials in most South African public institutions were directly involved in AT budgeting and procurement. However, they lacked the required knowledge about ATs. This implies that the allocations of ATs and the selection of other important products are usually undertaken by a few individuals who decide what to procure but lack knowledge of ATs and other technologies. This suggests that wrong devices can be purchased or delays in purchasing the ATs occur due to long consultation processes by individuals with limited knowledge of the devices. The longer it takes to procure a device, the more disadvantaged the students who need the devices are, and ultimately, the integration of the technologies in inclusive education was affected. This problem was alluded to by Participant 5, who said,

At times, I wonder what happens. One day it is about the shortage of money, the other day it is about the supplier or the order sitting in one of the offices in the university. We have students with special needs that require immediate attention in procuring devices. No one wants to be accountable. It's all long waits. Students yawn and yawn, they come to my office and end up referring them to the unit to find themselves. Some explanations do not convince at all.

The lack of understanding among those responsible for procurement is further emphasised by Participant 2, who says,

Even after I had explained what ATs were needed and what should be done, it seemed as if up until today the procurement committee does not understand what it means by human support and technology for special students. But even when you came to the devices, it was not easy for me

and the student to get that funding up until we had the meeting with the management who saw no reason to buy the devices when there were computers in the university.

There seems to be serious confusion among some procurement members concerning the ATs and general computers all students use. Accordingly, such confusion could be linked to a lack of policies and frameworks on the ATs in the university. Having people with limited knowledge of ATs in the procurement and budgeting process further leads to procuring the wrong devices from those not licensed or trained to sell the technology (Matter, 2020).

7.2.2.5. Lack of training among staff on how to use ATs

The use of ATs in the university was affected by the lack of training of lecturers who taught the students living with disabilities, as indicated by 66.2% of the respondents in the QUAN phase. Participant 2, the material developer, and Participant 4, the technologist in the university, attested that lecturers were not coming forth for training in the use of ATs, and this affected the use of devices to support students. Similar findings are reported by Judge and Simms (2009), who have observed that the lack of training among users and teachers on using ATs was one of the key factors overlooked by service providers in specialised technologies. Existing studies have observed that a shortage of relevant expertise in ATs can lead to poor acquisition of devices and their intended usefulness (Samant & Matter, 2015; Judge & Simms, 2009), which was also found in this study. Neither those responsible for procurement nor those who used them for teaching had adequate expertise to guide the process (Participants 3, 4, & 5). The setup in the unit was to meet the requirements from outside without putting the appropriate structures into place. Participant 3 said,

It is very difficult for us to find the lecturers so that we can train them on using ATs and inclusive education, but we are trying our level best in such a way that we can go far to educate our academics.

And Participant 4 said,

It has been an annual problem that lecturing staff do not come forward for proper training in ATs. There is limited awareness and training among faculty and staff because they hesitate and only come when there is a big problem. At times it was too late for any help for the students.

Existing studies report that the involvement of individuals without proper knowledge of ATs resulted in the prescription and provision of devices without the proper training and support

services being made available for the lecturers and support staff (Ahmed, 2018; Manase, 2023). Lack of training has its ripple effects, such as lack of familiarity with the equipment, partial awareness of specialised applications for aiding students as well as the inability of the staff to troubleshoot malfunctioning devices and applications (Carey and Sale, 1994; Coflan & Kaye, 2020). The training available to staff was for isolated rudimentary skills such as powering the devices and locating information from the Internet and technical aspects of devices at the expense of how to integrate devices in the teaching and learning space of students with disabilities. These findings were made in previous studies in the 90s, and the weaknesses persist today. Vincent, Okeowo and Ariyo (2024) report that when teachers were trained in ATs, it was all about technical and isolated academic skills, disregarding the need for crucial integration aspects. Furthermore, a study found that some common ATs available in the disability unit were not being used because the university was waiting for the staff to be trained by suppliers who rarely made follow-ups on the equipment supplied. Therefore, the lack of skills among lecturers and disability unit staff meant that the integration of ATs in inclusive education at the university was delayed because training needed to occur first so that lecturers and other staff got the required knowledge and skills in the ATs. Participant 2 indicated that lecturer resistance to training was prevalent at the university, implying that students with disability were taught by lecturers not qualified in inclusive education. This manifested a lack of training in the university and the disability unit. The lack of policies and framework to guide the integration of ATs in inclusive education in the university precipitated multifaceted challenges that disadvantaged the students.

Besides the lack of training of lecturers, the study established that staff deployed in the disability unit were poorly trained to offer quality services and support students and lecturers in integrating ATs into teaching and learning. This finding was expressed by all four participants, who felt that some of the staff in the disability unit at the university could not discharge their duties in assisting students with ATs because they were poorly trained. Most literature on ATs used in education only focuses on teachers and lecturers, not support staff.

7.2.2.6. Lack of framework or policies on AT purchases in the university

Another issue that affected the integration of ATs in inclusive education was the absence of policies in the university. Data from the qualitative phase of the study confirmed this finding. All participants indicated that the university did not have policies and frameworks to guide the integration of ATs into inclusive education. Instead, whatever the university tried to do, from the procurement to the use of ATs, was based on guidelines from outside the universities, which hardly addressed the problems faced by the students. Those who did use ATs to aid

academic activities did so on their own accord (Participants 1, 2 & 5). For example, Participant 2 said,

The is no framework here at the university. Unfortunately, we use this one they call White Paper 6 and also that one for the higher education policy for inclusive education, which is general. No one knows what software or devices should be acquired until a student pitches up with a problem. It would be better if a framework were available to guide the university on what should be done.

Similar sentiments were conveyed in this extract by Participant 5,

I am not sure if there is anything that informs us how to deal with ATs, particularly for general lessons involving standard students. It seems that lecturers and even those in management do what they see working. No one knows what should be done.

This situation is dire for students and lecturers who must use the devices in various university departments for academic purposes. Harniss, Samant, and Matter (2015) state that there are weak policies and improper legislation on the provision of ATs and their integration in most institutions. This study further found that even for the scant ATs available, they were poorly distributed as some students who could not use the devices took these and kept them for a long time before returning to the unit for circulation to others. The implication is that the unit did not regulate the distribution of the ATs, which affected circulation (Ndlovu, 2021) and overall integration in the teaching and learning processes. According to Visagiei, Scheffleri, Seymourii, and Mji (2020), South Africa lacks a firm AT policy. It hence relies upon many policies from public health, which are appreciably good because they align with significant elements of international policies but lack an intersectoral approach, and their awareness and implementation are poor in public space.

7.2.2.7. Inadequate assessment and planning processes

Assessment and planning of AT integration was found to be an influential factor but was inadequate. This was confirmed by 59% of the respondents and three of the four participants of the study. This finding is similar to Kolb and Griffith (2012), who found that teachers were aware of the benefits of ATs. However, they lacked the required experience and background knowledge or skills to properly assess and plan to use these technologies for the benefit of students. According to Kolb and Griffith (2012: 485), practitioners in education need knowledge and skills to "*facilitate effective person-centred planning for and implementing of*

Assistive Technology for students." The issue of Inadequate assessment and planning processes is also reported in a study by Copley and Ziviani (2004). According to Copley and Ziviani (2004), institutions need to assess individual students' AT needs, which can help locate and acquire suitable equipment that can be integrated into the teaching and learning of students at the university. While this is a good practice, some studies decry the inadequate standards, frameworks, or guidelines to inform the process of the AT assessment (Kolb & Griffith, 2012). This implies that the university should have an assessment centre to assess students with disability and their AT needs comprehensively. Without a proper assessment process, the disability unit can overlook essential aspects of the individual student's abilities, resulting in critical needs being overlooked at the random assessment stage usually done. Inexperienced or unscrupulous service providers may not give the assessment process due attention while focusing on doing business with the university, emphasising sourcing the equipment needed by the student, leading to purchasing the wrong ATs. The way a student can effectively access and use the device is usually ignored due to the wrong assessment process. Literature attests that students normally abandon ATs that do not meet their needs (Manase, 2023; Copley and Ziviani, 2004; Vincent, Okeowo, & Ariyo, 2024). Poor assessment leads to poor planning and, ultimately, the acquisition of inappropriate devices.

Besides assessing the AT needs of students, the study found that the university failed to assess the impact of AT use on students' academic performance and social life during the study period. The study found that most of the ATs were used in the disability unit, indicating that the university ignored the importance of the strategic placement of ATs and how they were integrated with other learning devices within the student's learning environment. Putting all ATs in the disability unit meant that those lecturers who wanted to integrate these devices during lectures were dissuaded. Considering the lack of policies and frameworks to procure ATs in the university, there was a high chance that some decisions were made outside the disability unit, depending on what the service providers brought to the university.

Another challenge related to poor assessment of AT needs was a lack of shared understanding and uncommitted disability staff, teaching, and procurement department involvement in the assessment process (Copley & Ziviani, 2004; Manase, 2023). According to Todis and Walker (1993), most staff members excluded from the assessment process were likely to avoid integrating ATs into inclusive education with students deliberately. From the utterance of Participant 4, it was clear that students living with disabilities only got support from the university, implying that their families were not involved in the purchasing of ATs and other technologies. This was likely to put students in an awkward position of lack of support from home, which could have been important during the assessment process. Consequently,

partially including individual students while excluding family in assessment and decision-making processes has a potentially negative effect on the ATs integration effort in the university as programs embodying family values were likely to be rejected by families and students' bodies. The assessment process, which disregards AT users' opinions and other socio-technical factors during the assessment stages, was likely to lead to the low integration of the technology in inclusive education due to students' rejection of the ATs. The university requires a proper policy or framework for consistency in the assessment process. Existing literature reiterates that the lack of family input during the assessment of ATs was likely to lead to the inappropriate prescription of these technologies, eventually leading to their resentment by students involved and poor use (Priest & May, 2001; Lund & Nygard, 2003).

Poor planning is a perennial challenge that affects the integration of ATs in inclusive education and is considered a recipe for advocating unrealistic outcomes for students' use of ATs for educational purposes in the university. According to Participants 1 and 3, there was not much planning in acquiring ATs at the university, and poorly informed administrators interfered. This outcome was consistent with prior research on ATs in various institutions. Fernández-Batanero *et al.* (2022) emphasise that planning is one of the essential ways of identifying barriers particular to individual students' ability to utilise ATs to aid their learning. Ahmed (2018) opines that practitioners who proactively consider how AT can influence student success and barriers likely to affect the use of ATs negatively are better placed to select appropriate technologies and assist students in using them for learning purposes. This study found that planning was lacking, and those who attended planning meetings were ignorant of inclusive education and the ATs that could be purchased. Consequently, inappropriate ATs were bought without sound decision-making.

7.2.3. Socio-technical challenges faced by students with disabilities in historically disadvantaged universities in South Africa

7.2.3.1 Negative staff attitudes

Findings from the Quant phase are corroborated by those in the Qual phase that staff at the university had negative attitudes toward ATs and their uses, which were detrimental to the integration into inclusive education. For example, 60% of the respondents affirmed that negative staff attitudes were a severe issue that posed a challenge that prevented the students from benefitting from integrating ATs in learning either in lectures or disability units. Several studies have identified negative staff attitudes as an influential social issue in the integration of ATs into education at any level in the academic journey of many students (Copley & Ziviani, 2004; Fernández-Batanero *et al.*, 2022). The negative attitudes of teachers could be traced

back to poor training of teachers in AT integration and assisting students (Kimberly, 2023). According to Participant 3, a student sourcing ATs believed lecturers and staff in the disability unit needed some training in ATs and how to assist students in adopting or adapting to the devices. *“I have witnessed situations where staff ignore students who are desperate for assistance because they lack know-how in ATs,”* Participant 3 said. A similar view was expressed by Participant 4, who said, *“...many complaints are made concerning staff who are not prepared to assist students with ATs.”*

7.2.3.2 Students' Poor Adaptation to ATs

Most respondents, 66%, were convinced that students with disability in the university failed to adopt ATs because of a lack of training. This was corroborated by Participants 3 and 5, who worked with students directly. Participant 3 said, *“Students who use the ATs for the first time find it difficult as they want to have been trained properly.”* Participant 5, *“I always find students with devices they have no clue of how to use...when you closely look at the problem, you find that they were allocated these without proper training.”* Past studies in AT use confirm that the lack of training on how to utilise the devices, maintain the devices, and look after devices' device functionality negatively affected the integration of ATs by students in their learning and other creative ways to use the technology (Parette, 2005; Kimberly, 2023). Students who faced adaptation problems were likely to discontinue using ATs, which seriously affected the integration of inclusive education. Because students were not adequately taught how to use the ATs, it implies that there was a lack of guidelines or framework informing the training of students who had no experience in using the devices.

Poor adaption to ATs manifested in several ways, including:

- a. Due to the extent of understanding the characteristics of devices, 74% of the respondents reported experiencing this challenge.
- b. Close to 54% of the students indicated being discouraged from integrating ATs due to logging into devices, which prevented them from accessing online content using devices.
- c. The inability to navigate online resources was a barrier indicated by 66.7% of the students who sought to utilise ATs for online sources of information.
- d. Regarding the extent of Internet use to find and retrieve information from various online sources, 56.4% struggled to find sources for academic use on the Internet.

These findings can be inferred from other studies that looked at the requirements of ATs about security and control (Pal, Hitchens & Varadharajan, 2020). The authors suggest that since most ATs that access the internet are IoTs, they need stringent access control for security purposes. However, this presents students with challenges, especially if they forget authentication details. Most students with disabilities seem to be unfamiliar with the ATs and need much time to learn how to operate them first and then integrate them into their learning (Holloway & Dawes, 2016). According to Holloway and Dawes (2016), ATs are disruptive technologies within the learning environment. They are likely to be rejected or frequently abandoned by users who fail to adapt to their seemingly complicated. Some studies allude to the need for ATs to have appropriate user interfaces to meet the unique needs of students living with disabilities. Pal, Hitchens and Varadharajan (2020) observe that some software designs produce static or limited usability artefacts, making it difficult to adapt to the needs of students with disabilities. Such ATs make it difficult for students to have enough control over integrating technology into inclusive education (Zajicek, 2004).

7.2.4. Requirements for a framework to improve the integration of adaptive assistive technologies in Inclusive Education in Higher Education Institutions.

Several findings were made from both the QUANT and QUAL phases, indicating that respondents and participants were aware of what the university could do to improve the integration of ATs in inclusive education. The findings focused on various strategies that could be treated as essential requirements for modelling the integration of ATs in inclusive education at the university. Findings on the appropriateness of ATs for students overwhelmingly indicated that many of the available devices and technologies meant to assist learners were not fit for the tasks they were intended for. This lack of fitness could be traced to many factors, including the lack of a framework to guide the university in integrating ATs into inclusive education. To address this anomaly, an effort was made to determine the requirements for such a framework.

7.2.4.1 Moderating factors to consider.

The ICF model has proposed moderating factors, which are essential requirements for implementing a program with students with disabilities. Most respondents, 83%, recommended that proper assessment of disabilities for each student should be done by the disability unit at the beginning of each semester to understand the underlying challenges which the provision of ATs can address. Two moderating factors were prominent among others: the need to identify disabilities among students (approx. 61%) and matching students' needs to the disabilities before purchasing or allocating available ATs to the students (approx

65%). It could be inferred from these findings that every assessment of students' disabilities was assessed, and the allocation of devices was random. Much has been said about the need to consider these moderating factors provided by the Student Environment Task Tool (SETT) framework (Cunningham & Lamond, 2021) or ICF (Martinuzzi, 2010; World Health Organization, 2007). These two frameworks encourage organisations and teachers to systematically assess ecological variables concerning students' needs and degree of disabilities before providing ATs. From these two theories, it is imperative to have insights into the student's disabilities, cognitive strengths and weaknesses; assess instructional and physical environment(s) in which the student works most of the time; assess the nature of the task(s) that have to be done by the student using the ATs, and the AT that best suits each student's needs (Cunningham & Lamond, 2021; Martinuzzi *et al.*, 2010; WHO, 2007). A study by Mishra *et al.* (2024) reports a lack of proper assessment of moderating factors as a leading cause of poor AT acquisition and integration in teaching and learning of students with disabilities. Much must be done to encourage organisations to consider this important factor, particularly in designing policies and frameworks. The needs assessment issue among students with disabilities is further emphasised in the best practice by Layton *et al.* (2016). These authors support the idea of needs assessment, which leads to selecting appropriate ATs that match each student's disability. This implies that organisations should desist from prescribing and procuring ATs without proper assessment of the needs of students. This is intended to prevent organisations from purchasing inappropriate AT, leading to the waste of scarce funds.

7.2.4.2 Timely procurement and allocation of appropriate ATs to students

The procurement of ATs was topical as most respondents (83%) categorically opined the need to improve this process by making timely purchases of the proper ATs from reliable service providers. Boot, Kahonde, Dinsmore and MacLachlan (2021) report poor access to ATs due to the inability of organisations to procure the proper technologies on time. AT procurement requires a lot of considerations, including moderating factors. This study found that the moderating factors were marginally accounted for, and no due diligence was made in the acquisitions of ATs, which usually occurs in the middle of the academic year. Without proper policies to guide the assessment of students' disabilities and their needs, the university ends up purchasing whatever service providers suggest. The blame is apportioned to poor funding, as evidenced by the interviews of Participants 1 and 3, who consistently alluded to the lack of money to procure ATs. Moreover, Participant 4 opined that universities lack AT procurement policies, resulting in those with little knowledge about inclusive education being the decision-makers.

Some respondents, 65.4%, indicated that the procurement process lacked transparency because students, lecturers and stakeholders were not included in the ATs selection processes. According to WHO (2021), the procurement of ATs is a specialised area which needs a multidisciplinary procurement team to decide on the specifications of the devices to be purchased. This study has established that the procurement of ATs in the university, detached from the realities of inclusive education, needs to be inclusive and consider stakeholders. The respondents and participants believed that including management staff who lacked knowledge of ATs and inclusive education required was detrimental to inclusive education. Instead, stakeholders, particularly the staff from the former schools and the students with disabilities, could be consulted for assistance with ATs. Procuring ATs without proper assessment of the student's needs led to the purchase of devices that were unfit for use in many cases. Due to this, 78% of the respondents affirmed that assessing the AT needs of students and matching to the tasks to be performed and the capabilities of the student to use the device was essential. This implied that most of the ATs available in the unit were unfit for academic purposes because they were unsuitable. However, there are challenges in involving students in the procurement stage because they may lack the required expertise to operate at this level. Having a framework can enable the procurement committee in the university to be cognizant of what is prevailing in inclusive education and reduce their overreliance on service providers concerned with economic benefits from the sale of ATs.

One suggestion towards improving AT integration in inclusive education was timely allocating the devices, as 70.3% of the respondents indicated. The delay in allocation could have led to students losing ground in their academic work and affected the integration of the devices. According to the WHO (2021), the delivery of ATs to organisations was vital as it made it possible for the devices to be in the hands of the users within the shortest time possible. Visagiei, Scheffleri, Seymourii and Mjii (2020) believe that existing ATs in good working order must be allocated based on reputable practical strategies supported by appropriate training that should be identified and evaluated for student distribution. However, their constructive ideas depend on the availability of a viable framework for integrating ATs into inclusive education.

Some critical considerations raised were the need to regularly conduct proper stock-taking of ATs in good conditions instead of waiting until students arrive. Besides, purchasing ATs without stock-taking could lead to duplicating the same devices, which students would not use, wasting scarce funds. The latter was blamed on the overreliance on suppliers and service

providers at the expense of the educational challenges ATs were supposed to alleviate. Furthermore, as a precaution to procurement, the study noted that the over-reliance on service providers and suppliers tended to emphasise the acquisition of ATs, disregarding the quality of the technologies and the need to match these to the expectations of the students.

7.2.4.3 Training in both technical and integration AT for students and staff

Similar to poor procurement strategies used by the university, training was strongly emphasised. The findings show that training on ATs was supposed to be offered to lecturers and students. Close to 75% of the respondents felt they should be trained to integrate ATs when teaching disabilities. Some respondents, 73.5%, believed that supporting staff in disability units needed the same training offered to lecturers and the technical one already given. Support for students who want to use ATs was found to be low, and therefore, 82.7% of the respondents suggested that this should be made compulsory for lecturers and staff working in the disability unit. Procuring and distributing ATs to students before training support staff and lecturers was found to be a setback to the integration of ATs in inclusive education. According to the WHO (2021), the service provider can train users on technical aspects of the ATs but not much in integrating the technology into inclusive education, which another department may do. A study by Suwahyo, Setyosari and Praherdhiono (2021) reports that a lack of instructions and proper training given to the students, teachers and family members on the safety and appropriate use of ATs was a barrier to individuals' utilisation of the technologies for academic and social use.

Even after providing initial training, 77.5% of the respondents were convinced that continuous training and developing lecturers on AT integration was an essential requirement. Suwahyo, Setyosari and Praherdhiono (2021) further raise concerns pertaining to the lack of participation and inclusion of family and, at times, caregivers when prescribing, distributing and training ATs. This implies that respondents felt the university should treat training in the AT area as a continuous process instead of a once-off event. Similarly, continuous training on AT use for students with disabilities in the institution was advocated for by nearly 60% of the respondents. Some of the moderating factors suggested were intended to address issues with lecturers. Close to 70% of the respondents suggested that lecturers in the university should be trained to understand unique needs so that they could treat students with disabilities with care. The findings further revealed that most respondents, 61%, were of the view that lecturers should allow students with disabilities to study at their own pace while monitoring them when using ATs. The integration of ATs was thought to be improved by lecturers, considering the volume

of student work. Close to 76% of the respondents believed that productive use of scarce ATs was severely affected by lecturers who overloaded students with work to complete.

The study found that close to 78% of the respondents suggested that most students could have integrated ATs into their academic work with proper lecturers and staff in the unit. It was further suggested that students with little knowledge of AT use needed adequate time to learn how to use the devices productively. The strategy to improve this was meaningful support by academic and support staff.

Training teachers and providing necessary support in AT use is emphasised by Safhi, Zhou, and Kelley (2019), who observe that most education institutions fail to assist students with disabilities due to a lack of knowledge and skills. The authors report that in many countries where efforts are made to train teachers, the programmes lack coordination, resulting in trainees failing to complement their knowledge and skills in the work area. Training in ATs was complicated by the diverse nature of ATs and the lack of support from the suppliers and providers. This study found that respondents considered the training of lecturers and students in technical and integration of ATs to be essential in developing a framework. As such, the interview results by two participants (Participants 1 and 3) advocated that the university put in place a policy that mandated the training of all lecturers in the university in ATs and that these technologies could be integrated into academic activities. According to Participant 4, training lecturers in ATs at the university was possible, but lecturers were not forthcoming as the training was optional for those who wanted it. This finding was similar to that made by Alkahtani (2013), who observed that by leaving the training optional, individual teachers hesitated to partake in it as they regarded it as unimportant and only relevant to those who wanted to use ATs. Programs to support and encourage students to use ATs were somehow functional in the university but minimal, leading students to give up on these technologies. Moreover, there were no support initiatives for lecturers who showed good intentions on ATs. Due to these weaknesses in the approach used at the university, the respondents overwhelmingly affirmed the need for policies and strategies to provide both technical and educational support and training to students and lecturers to sustain AT usage in the university. Therefore, the framework would have training policies and guidelines as requirements to prop up the AT integration. The literature emphasises the importance of service provision of suitable ATs on the success of every AT programme regardless of the technologies in question (McPherson & Clark, 2017; Visagiei *et al.*, 2020). AT suppliers and service providers must act ethically when supplying devices and training users instead of focusing on financial gains. According to McSweeney and Gowran (2017), the organisation acquiring AT must hold the suppliers and service providers accountable for the devices supplied and the training offered to ensure that

students benefit from technology investments. This can only be achieved if the university puts proper policies and guidelines in place for procurement and training programs.

7.2.4.4 Funding Strategies

The findings on the lack of funding for the purchase of ATs show that the university was in a dire situation to meet the needs of students. The university mainly relied on NSFAS for funds to purchase ATs. This implies that students without NSFAS or external funds would likely not get the ATs they needed. Parents or guardians of such students were not able to buy expensive devices. The findings further show that the university did not have a proper funding strategy or policy for ATs. Most respondents, 80%, indicated the need for the university to implement a reliable funding mechanism that ensures equitable access to ATs for all students in inclusive classrooms. In an interview, Participant 4 indicated that the university must move away from asking for monetary donations and instead source ATs as per student needs from local and international donors. There is a plethora of literature indicating the role played by donors in increasing the accessibility of AT by giving such devices to the population in general and students in particular (Marino *et al.*, 2015). South Africa's prominent donors to students with disabilities are churches, business fraternities, NGOs, and health organisations that can do that of their own accord or after being approached by the universities (Visagiei *et al.*, 2020). The challenge to this initiative is the lack of coordination among the donors as they make donations whenever they feel they may donate without asking the universities what is needed. According to Visagiei *et al.* (2020), restrictions are put in place by the government and the institutions on who donates and the type of donations made. This is usually intended to reduce some unwanted business dealings that can lead to reputational damage to the universities and the department. Although South Africa has a comprehensive, inclusive education system, institutions of higher education are found lacking in providing adequate ATs that match the needs of students due to poor funding and relying on meagre donations from wellwishers (Ndlovu, 2021). Besides, several studies on the provision of ATs rarely put forward innovative ideas on how higher institutions can improve the quality of ATs available but they focus much on peripheral issues of essential use by students. Without proper policies on funding and equitable distribution of ATs to students based on needs, the programs are bound to remain in the doldrums. According to Harniss, Samant Raja, and Matter (2015), challenges that exist in the supply of ATs are due to limited funds, weak policies and legislation, poor distribution of meagre resources as well as a severe shortage of relevant expertise in making good decisions, and selections of devices (Fichten, Olenik-Shemesh, Asuncion, Jorgensen & Colwell, 2020). Therefore, there is a need to put frameworks in place to assist these institutions in overcoming these challenges.

7.2.4.5 AT integration strategies

The findings clearly show that no proper AT integration strategies were in place, and the process depended on the initiativeness of the lecturers and support staff who were willing to do so. To improve the integration of ATs in inclusive education, strategies need to be put in place to that effect. Suggested AT integration strategy requirements were policy-driven student-centred AT integration, as indicated by 80% of the respondents, and stakeholders' collaboration in AT integration in inclusive education, as indicated by 75%. Much of the existing literature describes the implementation of ATs in teaching and learning without much reference to policies being used to guide such processes. For example, Van Laarhoven, Munk, and Chandler (2012) describe a successful process of enhancing AT use in a high school but lacks guidelines indicating such a successful project. Similarly, Alkahtani (2013) identified a similar problem to the one pursued in this study, but the author proposed an AT adoption framework for organisations; such a framework and policies could not be of much use in this study as the university in question already adopted and facilitate the use of the ATs by many students. Policies seeking to place students' needs and including parents in their quest to integrate ATs can foster a strong foundation for the role played by these devices in students' academic lives. Policy-driven student-centred integration can seek to achieve the following: access and needs of ATs, reining in of providers and suppliers to provide quality and appropriate ATs; address the availability of appropriate ATs matching students' needs at an affordable price preferably subsidised, and raise strong awareness of the importance of ATs in the university (Harniss, Samant Raja & Matter, 2015; Fichten *et al.*, 2020).

7.3 APPLICATION OF THEORETICAL FRAMEWORK

7.3.1. Variance

According to Cloutier and Langley (2020), variance theories help deal with conceptual constructions by examining how variables relate. However, process theories examine conceptual constructions focusing on how phenomena emerge, change, or end over time through activities and events.

a) Task technology fit theory

This study applied the TTF variance theory to examine the factors influencing the integration of ATs in inclusive education at one of the disadvantaged South African universities. To apply the theory, quantitative data dealing with variables about the demographic characteristics of

the sample used, the types of ATs used, frequency of use, socio-technical factors affecting the students with disabilities, the appropriateness of the ATs in meeting the needs of the students, and the requirements for proposing a framework to promote the integration of ATs. The integration of ATs in inclusive education is the dependent variable, and this study sought to determine how it was affected by many other variables. Although the findings seem to point to a high frequency of students using ATs, this was not for meaningful academic purposes but for trivial tasks because most ATs were functionally unsuitable for the challenging assessment and learning tasks students were required to complete. Most students failed to adapt to the ATs because the technologies did not meet the student's needs, making them unsuitable or inappropriate for integration into their learning. It could be inferred from the findings that the students who were investigated faced challenges in using ATs as they could not do so. No proper training was provided, and they failed to operate the ATs alone. They were not included in the selection of the ATs, which led to their needs being wholly ignored. Due to the mismatch between students' needs and the ATs supplied, students were incompetent in using the technology to support learning, rendering their academic performance average or poor. Most of the variables were independent of the characteristics of the demographic information, implying that no differences existed in how these challenges affected the students. Instead, students were more concerned about the volume of work given in the face of their dilemma. The integration was further affected by factors including funding, poor training of lecturers and support staff, over-reliance of the university on the suppliers, and service providers who took advantage of the procurement committee members with little knowledge about ATs. Ultimately, the findings pointed to the need for the university to consider putting in place a framework to promote the integration of ATs in inclusive education, which seeks to assess students' disabilities and select the ATs that match students' needs and tasks to be completed.

7.3.3. Process

a) DeLone and McLean information systems (IS)

The DeLone and McLean information systems (IS) success model is the process model used to understand the participants' views on the benefits of AT integration in inclusive education. This theory allowed the researcher to identify the underlying issues from the participants' views, sentiments and lived experiences concerning the practices, challenges, and potential solutions to the difficulties experienced by the university in AT integration. Findings from the qualitative data revealed that very little progress was being made in integrating ATs into

inclusive education as participants exposed significant challenges that needed to be overcome. Firstly, the ATs in the unit were of poor quality, with most malfunctioning or just being inappropriate for use. The service quality was poor due to insufficient funding for new technologies. The desire to use ATs for learning was initially high, but this decreased as users got frustrated with unavailable devices. The integration of ATs in inclusive education was generally low as there was a mismatch between the ATs' needs for students and the tasks to be completed. Similarly, lecturers and support staff were not forthcoming in addressing the integration issues as they believed that the procurement committee and the management were doing too little or lacked the motivation to promote inclusive education per se. The findings from the qualitative data corroborated those from the quantitative data, signalling the need to put strategies in place to solve the impending challenges faced by students and improve the integration of ATs in inclusive education. Nonetheless, a framework to address the situation was suggested by participants to put forward the requirements for that cause.

Amalgamating the findings from the variance and process theories culminated in the proposal of a requirements framework for integrating ATs, which is dealt with in Chapter 8.

7.4. SUMMARY

This chapter presented a comprehensive literature-controlled discussion of findings made from both quantitative and qualitative data. The discussions led to the realisation that a lack of proper strategies seriously compromised the integration of ATs in the university. Some of the strategies were suggested and can be expanded to a framework together with best practices done somewhere else. The integration has been improved over decades of caution and elaborate work by various university teams. The next chapter is on the proposed framework.

CHAPTER 8: AT FRAMEWORK DEVELOPMENT AND VALIDATION

8.1. INTRODUCTION

Chapter 5 presented a detailed quantitative data analysis and interpretation. Results were collected from 71 respondents using an online questionnaire. The results show students' inconsistent and infrequent use of ATs, shortages of appropriate devices, and primarily a lack of training on how to use devices to support their integration. The study went on to establish and report several socio-technical issues negatively affecting students' access to and use of ATs to aid their learning. Requirements for the framework for integrating ATs were tentatively established and summarised into five categories: moderating factors, AT procurement strategies, training strategies, funding strategies, and inclusivity policies.

Chapter 6 presented findings from qualitative data analysis from five participants, challenges faced in integrating ATs, and the solutions that can be put in place. The lack of a proper framework resonated powerfully among the challenges and solutions among the participants. The results in Table 6.2 show the Ten (10) Challenges that all point to integrating ATs in inclusive education, and the solutions that can be implemented were listed.

Chapter 7 presented a detailed discussion of the findings of the study. The discussion was conducted based on research questions guiding the study. The main research question was answered and investigated in both Chapter 5 and Chapter 6. The findings focused on various strategies that could be treated as essential requirements for modelling the integration of ATs in inclusive education at the university. The proposed framework is based on the findings discussed in the previous chapter.

This study aims to develop a framework for integrating Assistive technologies in inclusive education for use in the disability unit at the University of Venda.

8.2. MAIN RESEARCH QUESTION BEING ANSWERED AND FINDINGS.

The finding of this study showed that there is no framework to integrate Adaptive Assistive Technology to guide and govern the institution. These findings justified the proposal of a framework for integrating Adaptive Assistive Technologies in inclusive education at a historically disadvantaged South African University. The following are the main findings of the study:

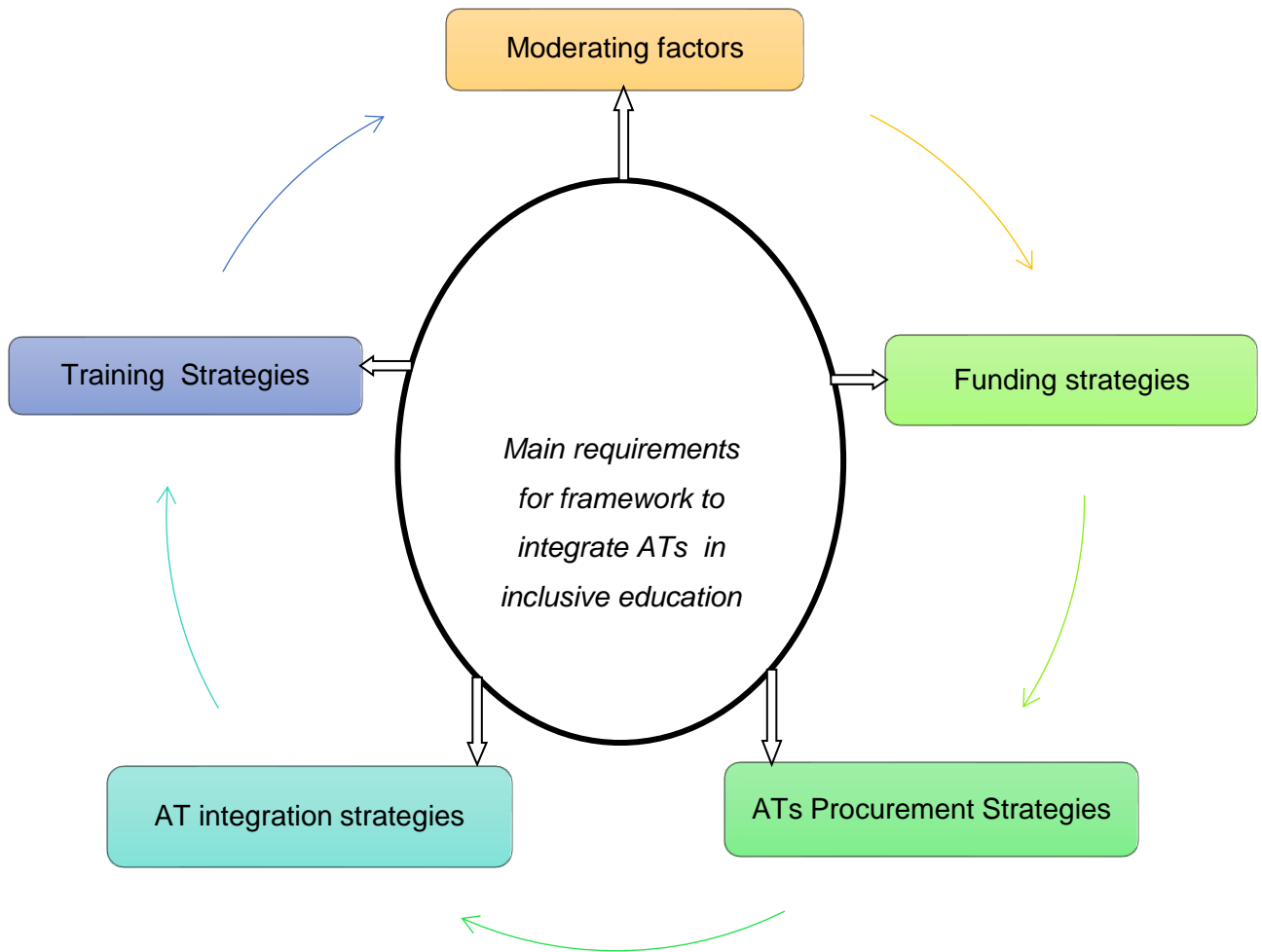


Figure 8. 1: Key Components of IAATIE

a) Moderating factors

These are the main components and critical factors considered as the foundation of a framework or a system.

Moderating elements are fundamental components of a framework that operate as foundational pillars, impacting various parts of the system or model to which they belong. They have an essential role in shaping the framework's general structure and function, with substantial implications for its performance and consequences. These characteristics frequently play an essential role in shaping how other framework aspects interact and function. Understanding and resolving moderating factors allows stakeholders to manage issues better and optimise the framework's efficacy.

b) AT procurement strategies

The procurement policies and high-level action plans outline the requirements for delivering assistive products and services. The specifications ought to take user needs into account. This comprises the procurement team, dependable suppliers, and processes to ensure that the procurement procedure is being monitored.

Implementing procurement strategies for assistive technologies offers a methodical way to meet the requirements of people with disabilities and advance their empowerment and inclusion. By integrating these techniques into a framework, stakeholders, legislators, and practitioners can establish a cohesive and long-lasting ecosystem for acquiring and applying assistive technologies.

c) Training strategies

These are the training policies, guidelines, and procedures. It clearly states when training should be done, how to train, who to train, and how long training should last.

Training strategies are vital to a comprehensive framework for providing and using Assistive Technology . Addressing training needs and promoting best practices in Assistive Technology adoption help create supportive environments that allow people with disabilities to live independent and fulfilled lives.

d) AT funding strategies

These are the policies and plans to secure funding for ATs. Funding strategies significantly impact the design and implementation of an Assistive Technology framework. Funding strategies can catalyse efforts to expand access to assistive technologies and improve the quality of life for people with disabilities by allocating financial resources, identifying objectives, building collaborations, and pushing for legislative change.

e) AT integration strategies

The policies in which no one is excluded, marginalised, mistreated, or prevented from accessing resources, responsibilities, opportunities, or benefits.

AT integration policies create the groundwork for the development of framework adoptions to support the proper implementation of assistive technologies and promote

inclusion for all students by establishing legal mandates, promoting accessibility principles, fostering collaboration, allocating resources and monitoring progress.

The key components in Figure 8.1 was intended to foster integrated Adaptive Assistive Technologies in inclusive education at a historically disadvantaged South African University. Each component consisted of activities that must be considered in the decision-making process. Each component of the ATs is elaborated in the framework analysis section. A checklist for each element was designed to guide framework users during the evaluation process.

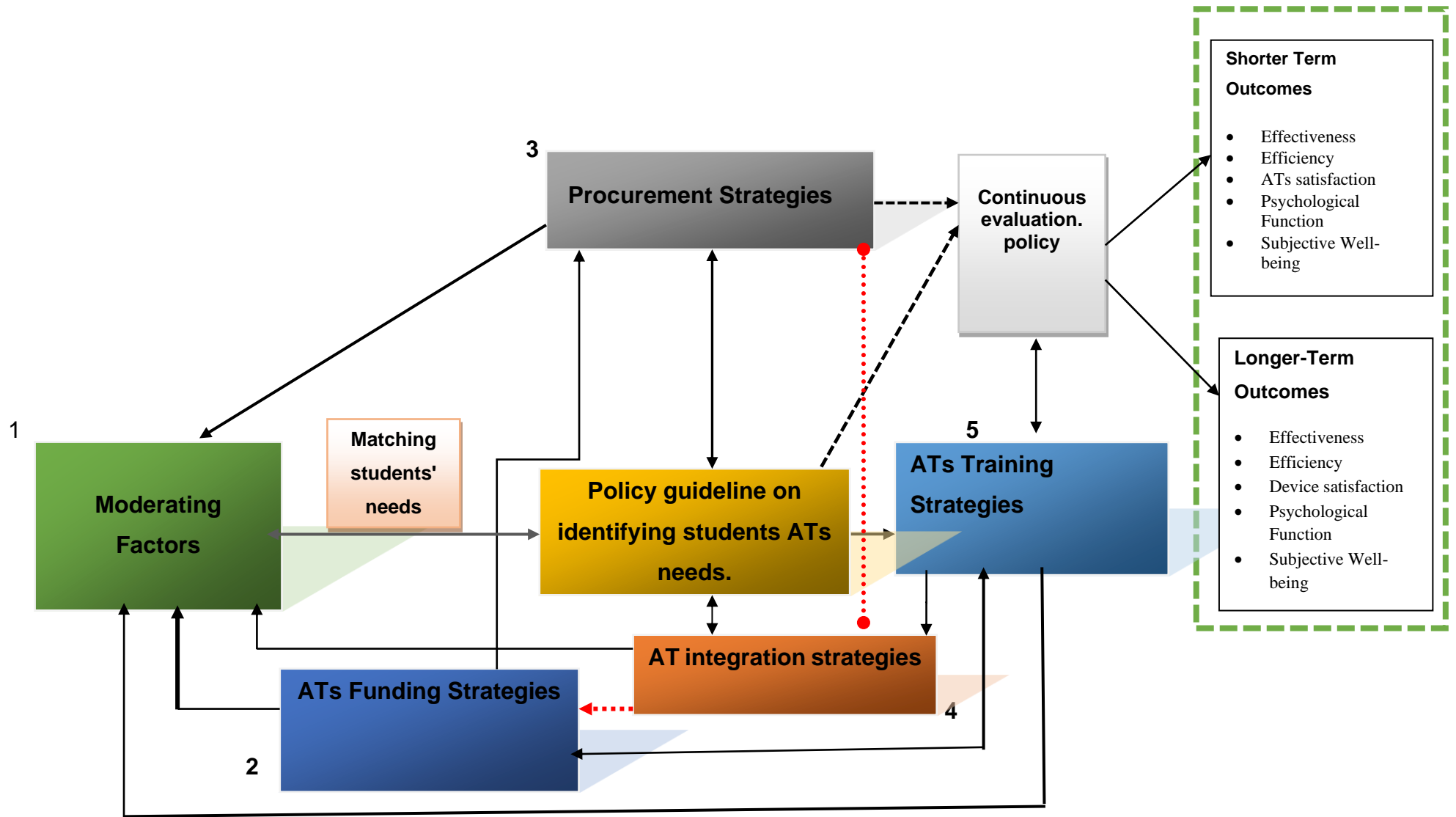


Figure 8. 2: IAATIE – integrate ATs in inclusive education proposed framework.

8.3. DISCUSSION OF FRAMEWORK COMPONENTS (LITERATURE CONTROLLED).

INCLUDE METRICS OR GUIDELINES.

A full description of the AT framework is given, based on each of the five components, and graphics highlight the important actions that each component would succeed with. A checklist and a set of criteria for evaluating each component are included. The diagram for the ATs Framework in Figure 8.3 shows details of each element to be considered. The IAATIE framework was developed based on the study's findings and can be used to understand how ATs are used in institutions and meet the demands of users. It is a comprehensive framework that takes into account the process of acquiring ATs, including moderating, training elements, integration techniques, and continual policy review. This framework considers critical variables that have been disregarded by other frameworks, particularly factors related with the procurement of the Assistive Technologies.

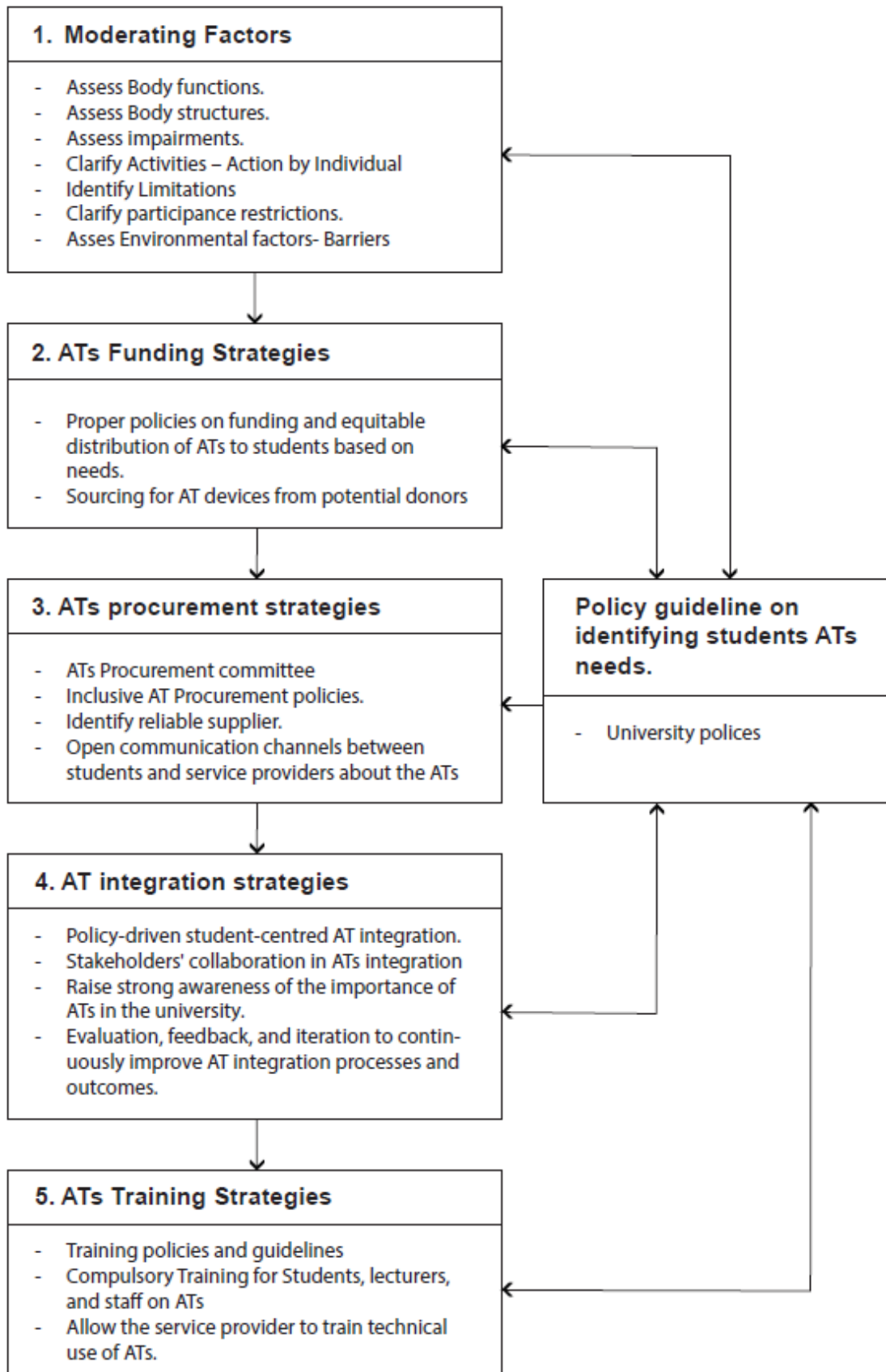


Figure 8. 3: Expanded IAATIE Framework

8.3.1 Framework Analysis

a) Moderating factors

The first components of the frame are the moderating factors, the identification of disabilities among students and matching the needs of the students. Experts should do this process. The ICF views a person's level of functioning as a dynamic interaction of her or his health problems, environmental variables, and personal characteristics. It is a biopsychosocial model of disability which combines social and medical concepts of disability. The following factors must be considered:

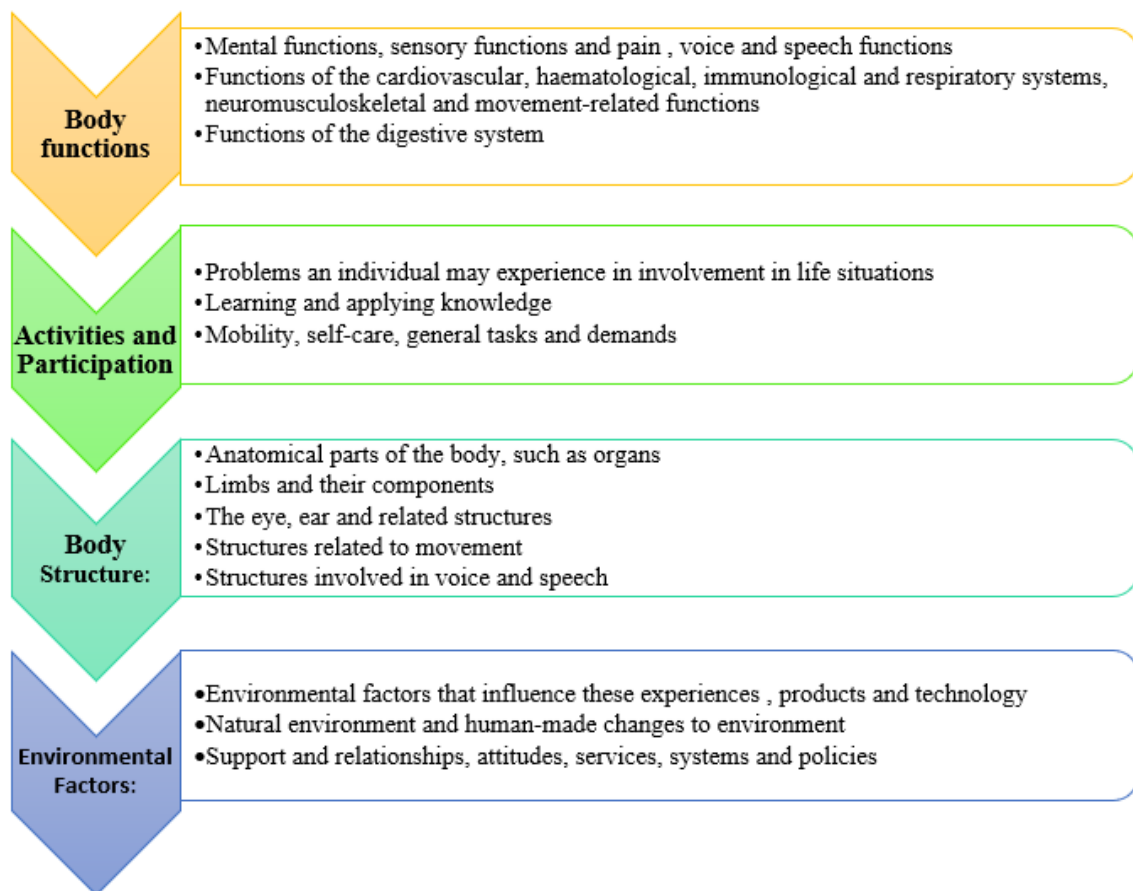


Figure 8. 4: ICF Moderating factors

b) AT Funding Strategies

Proper policies on funding and equitable distribution of ATs to students based on needs are the most critical fundamental components of the funding strategies to be considered within the universities, as well as inclusive policies for all. Sourcing AT devices from potential donors should be a strategy to assist students living with disabilities. A funding proposal must be submitted to potential funders to assist needy students.

C) AT procurement strategies

By developing inclusive procurement practices for Assistive Technology , educational institutions can significantly enhance the support provided to students with disabilities. These practices ensure that the Assistive Technology solutions acquired suit the student's individual needs and empower their learning and active participation in academic activities. Moreover, involving students, instructors, and parents/guardians in the selection and acquisition process fosters collaboration and ensures that the chosen ATs genuinely address the challenges and requirements of the students. Ultimately, the goal is to establish an environment where all students, regardless of ability, have equal opportunities to excel academically and realise their full potential.

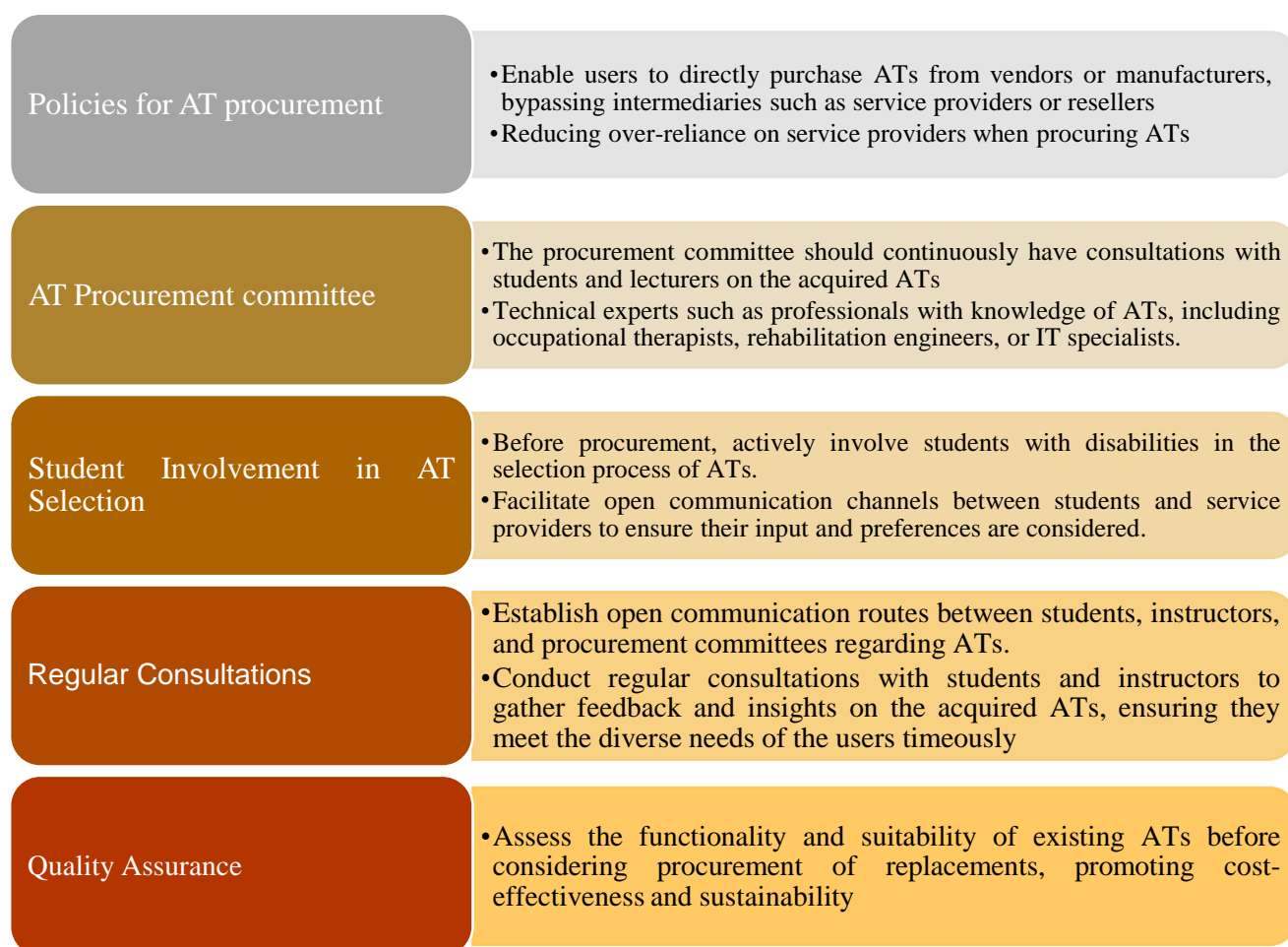


Figure 8. 5: ATs Procurement process

d) AT integration strategies

Develop and implement policies at various levels of education governance mandating the integration of ATs. These policies should outline AT implementation requirements, guidelines, and support mechanisms. A student-centred AT integration approach program should be utilised to monitor the process. Guidelines and frameworks should support adopting and using ATs to enhance the learning experience for all students. Stakeholders such as students, faculty, administrators, IT professionals, and disability support services partake in the process of integrating ATs. Collaboration ensures that diverse perspectives are considered and that the implementation of ATs aligns with the university's overall goals and objectives.

e) AT training strategies

Comprehensive policies and standards outlining the training requirements and expectations for students, lecturers, and staff regarding the use of ATs should be developed. These policies should clarify the types of training available, the methods of delivery, and the resources allocated to support training initiatives. Making training on ATs mandatory for all university community members ensures that everyone understands how to effectively utilise ATs to enhance accessibility and inclusivity in academic and non-academic activities.

Collaborate with AT service providers or technical experts to deliver specialised training on the technical aspects of using ATs. This could include training sessions on how to set up, configure, troubleshoot, and maintain ATs to ensure optimal performance and user experience.

8.4 FRAMEWORK VALIDATION

The framework for Integrating Adaptive Assistive Technologies in Inclusive Education (IAATIE) was presented and analysed based on the study's findings. Samples of checklists to aid the integration process were presented for each component. This section provides a detailed validation of the IAATIE Framework and checklist applicability to different professionals and decision-makers at the University of Venda.

After developing the proposed framework, validation was undertaken to determine whether the IAATIE framework reflected what policymakers expressed and its potential usefulness. The validation answered the main research question: *What are the main requirements for engineering modelling for developing a framework to integrate AT in inclusive education at a disadvantaged South African University?* The validation procedure provided an opportunity to

present the proposed framework for review by decision-makers who provided the fundamental ideas. Hariyanto, Triyono, and Köhler (2020) defines validation as evaluating a system and its components during or at the end of the development process to determine if it meets the specified requirements. Validation is a crucial criterion of a model or framework since it determines its trustworthiness, credibility, and usability in its applicable field (Gangemi *et al.*, 2008). This demonstrates that validation was utilised to show that the framework satisfied a reasonable range of correctness for its intended application by university decision-makers (Kit, 1995; Sargent, 1984). However, Rykiel (1999) suggests that a framework should be rated more on its usefulness than its validity. This indicates that academics should aim to make their conceptual content acceptable to experts and consumers instead of just rationalising the entire reality or proving that their framework is the best one accessible (Rykiel, 1996). Sargent (1984) defines a credible framework as one in which a user may confidently make scientific and management judgments. As a result, credibility is used throughout this study. Credibility has an appropriate level of acceptability in validating IAATIE, justifying its usage for IAATIE Framework evaluation and decision-making. According to the literature, credibility has the advantage of being related to the framework's specific context, including the amount of knowledge accessible, the goal of the framework, and the risks of any judgments made based on it (McLeod, 2013; Rykiel, 1996; Kit, 1995). The IAATIE was validated for relevance and acceptance using content (requirements), relevance, and acceptance by Disability Unit staff, students and university decision-makers.

8.4.1. Criteria for validation

This framework was validated for content (requirements), relevance, and acceptance in the following subsections:

8.4.1.1 Content (Requirements)

The data for content validity were collected using an online questionnaire from 15 respondents, namely, academic practitioners, IT practitioners, health specialists, HODs, and finance Procurement Managers. The results are depicted in Table 8.1.

Table 8. 1: Respondents for content validation

Role respondent	Number
Specialists in the health sector	2
HOD	2
Finance Procurement Manager	2
Academic practitioner	3
Technology- IT Practitioner	5
Total :	15

The results show a fair representation of the critical stakeholders in the university, and their responses to most of the validation issues were considered essential in the content, relevance, and acceptance of the developed framework. There are more technology IT practitioners (5) than any other respondents, followed by academic practitioners (3). Only one specialist in health was involved.

8.4.2. Validation of framework requirements

The 15 stakeholders validated the inclusion of each requirement of the framework by indicating whether the component must be included or not. The results are depicted in Table 8.2.

Table 8. 2: Validation of framework requirements

Component (n = 15)	Include	Do not Include	Total
Moderating factors	15	0	15
AT procurement strategies	14	1	15
Training strategies	15	0	15
Funding strategies	13	2	15
AT Integration strategy	15	0	15

The results show that all respondents indicated that the four components should be included in all cases except Funding strategies. Overall, the results indicated that all the requirements

were supposed to be included in the framework. However, it was necessary to validate the framework for relevance before accepting it.

8.4.3. Relevance

The framework's relevance validation was done based on each of the five components. Data was collected using a survey questionnaire from 30 students and 15 stakeholders who participated in the first stage. The validation was based on a 4 point Likert scale (4 = the component is highly relevant; 3 = the component is quite relevant; 2 = the component is relevant and 1 = the component is not relevant). The frequency distribution of the ratings by the respondents is shown inclusive of the percentage and respective means and standard deviations in Table 8.3.

Table 8. 3: The validation of the relevance of the components of the framework

Component	Highly relevant N(%)	Quite relevant N(%)	Relevant N(%)	Not relevant N(%)	Total	Mean	Std
Moderating factors	19 (42)	16 (36)	10 (22)	0 (0)	45 (100)	3.6	0.1
AT procurement strategies	16 (36)	13 (29)	15 (33)	1 (2)	45 (100)	3.5	0.2
Training strategies	14 (31)	18 (40)	13 (29)	0 (0)	45 (100)	3.4	0.1
Funding strategies	22 (49)	11 (24)	12 (27)	0 (0)	45 (100)	3.8	0.1
AT Integration strategy	18 (40)	14 (31)	13 (29)	0 (0)	45 (100)	3.6	0.1

The results show that all five components were rated as being relevant, as shown by most of the rating frequencies being relevant to highly relevant. For example, all respondents rated moderating factors as relevant to highly relevant, with a mean value of 3.6. Similarly, all other components were rated relevant, as shown by the means above 3. The next step was to validate the acceptance of each framework component.

8.4.4 Acceptance validation

Although all components were validated as relevant, the study needed to determine the extent to which each component was included. The degree of acceptability of each component of the IAATIE framework was validated using a 3-point Likert scale (3 = highly acceptable, 2 = acceptable and 1 = not acceptable). Table 8.4 shows the results as frequency distribution and the means.

Table 8. 4: Framework requirements acceptance validation

Component	Highly acceptable n (%)	Acceptable n (%)	Not acceptable n (%)	Total n (%)	Mean	Std
Moderating factors	31 (69)	13 (29)	1 (2)	45 (100)	2.9	0.1
ATs procurement strategies	28 (62)	15 (33)	2 (4)	45 (100)	2.7	0.1
Training strategies	20 (44)	24 (53)	1 (2)	45 (100)	2.6	0.1
Funding strategies	25 (56)	18 (40)	2 (4)	45 (100)	2.8	0.1
ATs Integration strategy	19 (42)	24 (53)	2 (4)	45 (100)	2.6	0.1

According to the results shown in Table 8.4, the mean for each requirement was above 2.5, indicating that most respondents who participated in the study rated each component as being highly acceptable. Moderating factors topped the list with 98% (mean \pm std: 2.9 \pm 0.1). This finding indicates that each component was accepted as valid and playing an essential role in the framework for integrating ATs in inclusive education at the university.

The overall validation of the framework was essential to ascertain that it was usable and clearly laid out and that the language used was easily updatable.

8.4.1.4 Overall validation of framework for acceptance and usability

For overall validation, the 45 respondents were asked to indicate using “yes” or “no” for each of the critical aspects that a framework validated. The results are in Table 8.5.

Table 8. 5: Overall validation of the framework

Items (n = 45)	Yes n (%)	No n (%)	Total n (%)
The language used is suitable	42 (93)	3 (7)	45 (100)
Layout is clear	43 (96)	2 (4)	45 (100)
Components are well explained	44 (98)	1 (2)	45 (100)
Framework is implementable	43 (96)	2 (4)	45 (100)
The framework's overall relevance	45 (100)	0 (0)	45 (100)
The framework is overall acceptable	45 (100)	0 (0)	45 (100)
Usability of framework	44 (98)	1 (2)	45(100)

The results for overall validation in Table 8.5 show that 93% of the respondents indicated that the language used in the framework was suitable, and 96% affirmed that the layout was clear. The results further show that each component was clearly explained by 98% of respondents, and the framework was implementable as confirmed by 96% of the respondents. Finally, the framework was overall validated as implementable (96%), Overall relevance and acceptability (100%). This means that the developed framework was validated as appropriate for integrating ATs in inclusive education in higher education.

Conclusion

This chapter presented the process of framework development and elaborated on critical components. The framework was developed and validated based on content, relevance, acceptability, implementability, and usability. The development of the framework was guided by findings from the study's quantitative and qualitative phases. The next chapter provides conclusions, contributions, limitations, recommendations, and further studies.

CHAPTER 9: CONCLUSIONS, LIMITATION AND RECOMMENDATIONS

9.1. INTRODUCTION

The previous chapter elucidated the framework development based on the study's findings and the best practices. The chapter illustrated that the framework requirements were validated for content and relevancy using stakeholders and students. This ultimate chapter presents conclusions, contributions, limitations, and recommendations for the study.

9.2. SUMMARY OF THE STUDY

This study resulted from problems in the dispensation of inclusive education at a disadvantaged university where students with disabilities faced challenges in their academic study due to a shortage of ATs. The study comprises nine chapters, each dedicated to an important aspect.

The introduction and background of the study are presented in Chapter 1. The chapter gave insights into the issues of providing inclusive education at the university and how students were disadvantaged in their studies. The study was designed to answer the main research question: *What were the main requirements for engineering modelling for developing a framework to integrate AT in inclusive education at a disadvantaged South African University?*

The main research question was divided into four subquestions stated as:

- a) What was the impact of Adaptive Assistive Technologies on enhancing inclusive education at a historically disadvantaged South African university?
- b) What factors were influencing the integration of ATs in inclusive education at a historically disadvantaged South African university?
- c) What socio-technical challenges are faced by students with disabilities in historically disadvantaged universities in South Africa?
- d) What were the requirements for a framework to improve the integration of adaptive assistive technologies in Inclusive Education in Higher Education Institutions?

Chapter 2 included a detailed literature analysis on inclusive education ATs and how they are supposed to be utilised by students in the university. Literature was drawn from various scholarly issues, including peer-reviewed conference papers and journals. The findings from the literature highlighted the important role of ATs in promoting the academic well-being of students living with disabilities. The literature also revealed that efforts were made to provide ATs to improve the student's socio-economic status and, ultimately, the country if the health aspects of the students were appropriately maintained. Furthermore, the literature indicated

that many issues surrounded the provision of ATs due to perennial problems such as poor government funding and a shortage of devices in the local market. The theoretical underpinnings of the study are presented in Chapter 3. This study used the IS theories based on the variance and process perspectives to collect data presenting a balanced view of the respondents and participants on the topical issue of ATs. The variance theory used was TTF deployed to determine relationships between variables at play in the provision of ATs and how they interacted to influence the provision of the technologies. The process theory used was the D&M, which facilitated the understanding of the problem from the lived experiences of the participants in the university. Chapter 4 offers the research design and methods employed in this study based on the Research onion model. The study used an explanatory sequential mixed method, which enabled the collection of quantitative data to determine the influence of the variables at play. Then, quantitative data was collected and analysed to corroborate the findings. Data were quantitatively analysed using SPSS version 29, while qualitative data was thematically analysed. The reports are presented in Chapters 5 and 6, respectively. Chapter 7 provided a detailed discussion of findings supported by the literature. Chapter 8 elaborated on each framework requirement and the developed framework for ATs integration. This chapter further presented results on the validation of the framework. Ultimately, Chapter 9 presented the study's conclusions, contributions, limitations, and recommendations.

9.3. CONCLUSIONS OF THE STUDY

The conclusions of this study pertain to each of the three sub-research questions and the main question.

9.3.1. What was the impact of Adaptive Assistive Technologies on enhancing inclusive education at a historically disadvantaged South African university?

Although many studies indicate the potential contribution of ATs in higher education, this study found mixed feelings about this aspect at the unit of study. The impact of ATs was relative and contextual to who was involved; this was not a direct intended outcome by the university. Therefore, the study concluded that the ATs did not have the desired impact as they were hardly integrated into inclusive education across the university. For those who did use the ATs, it was due to their effort, and this was done sporadically as there were no policies and proper ATs to guide the integration.

9.3.2. What factors were influencing the integration of ATs in inclusive education at a historically disadvantaged South African university?

Several factors were found to affect the integration of ATs in inclusive education at the university. These included:

- Inadequate ATs meant that students who deserved to use the technology spent most of their time struggling in conventional classes.
- Unsuitable and old ATs were unusable by students or lecturers who despised doing so.
- Policies and frameworks to guide the use and integration of ATs are important for the university. In this particular case, these were missing, and those lecturers who wanted to integrate ATs did that due to their willingness, but it was irregular.
- Funding challenges that constrained the purchase of appropriate ATs. ATs are generally expensive and are supposed to be tailored to students' needs. However, in this case, there was a serious shortage of funding for acquiring these devices.
- Train lecturers and students to use ATs for learning and teaching purposes. The study found that this area was neglected as there were no workshops to assist learners in acquiring the requisite skills and knowledge for using ATs. Training was given mainly on simple technical issues about the device itself.
- Service providers determined what ATs the university should acquire regardless of whether the technologies met students' needs.
- Lack of knowledge of ATs by the procurement committee members meant that the wrong ATs were often bought at very high prices.
- The willingness of stakeholders to work together was generally eroded.

Due to these factors, the study concluded that several factors influenced the integration of ATs in inclusive education at the university, and these need to be addressed urgently. The main influencing factor was the lack of a framework to guide the integration of ATs.

9.3.3. What socio-technical challenges are faced by students with disabilities in historically disadvantaged universities in South Africa?

The study found that students experienced a few socio-technical challenges that negatively affected the integration of ATs in inclusive education. The main challenges were a lack of ATs matching their needs, delayed distribution of the same limited technologies, overloaded homework they were supposed to complete at the same time as normal students, and poor skills in using the available ATs. The study concluded that students living with disabilities were seriously marginalised due to several socio-technical issues that the university could address.

9.3.4. What were the requirements for a framework to improve the integration of adaptive assistive technologies for Inclusive Education in Higher Education Institutions?

The study found that the biggest challenge to integrating ATs into inclusive education was the lack of frameworks and policies guiding the university. The key requirements for the framework were:

- Moderating factors which were to do with the different disabilities of students' key to identifying the AT needs.
- AT procurement strategies were found to be left in the hands of the procurement committee, which lacked much knowledge of ATs and inclusive education. There was a need to synchronise AT procurement, training, and integration to enhance inclusive education in the university.
- Training strategies were barely defined, leading to irregular programmes being given at the IT person's discretion. These strategies were needed to guide training needs for ATs in the university.
- Funding strategies were identified to address the perennial problem of cushioning students who did not have proper funding or those whose funding was made available late in the year.
- AT integration strategies were needed to address how ATs were used in the university during teaching and learning.

The study concluded that an appropriate framework should be developed based on the identified requirements. The framework was developed and validated as relevant, usable, and acceptable.

9.4. CONTRIBUTION OF THE STUDY TO THE EXISTING BODY OF KNOWLEDGE

This study has limited its scope to requirements for modelling the integration of ATs in inclusive education in one of the disadvantaged universities in South Africa. The study's contribution was the framework for integrating ATs, which was developed based on the requirements emanating from empirical findings and the best practices in published literature. This contribution is supported by scholars who acknowledge that artefacts such as a new model, a methodology, framework, and guidelines are fundamental to functional knowledge, which is essential in bringing about action with positive outcomes in organisations within the business and academic communities (Agerfalk, 2010; Scott, 2016). The scientific contribution of the framework from this study is functional and prescriptive knowledge important in IS research, as well as providing universities with appropriate guidelines for integrating ATs in inclusive

education to improve the academic participation of students living with disabilities. The framework developed in this study contributes to the knowledge needed to solve a university's real-world problem of integrating ATs to benefit students (Kelly & Cordeiro, 2020; Goldkuhl, 2012). Before the study, critical players in education provision, those tasked with procuring ATs and service providers operated disjointly without specific guidelines for their roles in integrating ATs in inclusive education. Applying this framework is likely to bring these to a common cause. This framework shows the synergy needed to solve a problem among various entities in the university, which was overlooked before.

Besides contributing to academic and scientific knowledge, the framework has practical applications that can assist the university in identifying militating factors that interfere with integrating ATs. This framework shows how different stakeholders, including students and their parents, can work together to solve the problem. This study has shown that it is essential for the university to have a framework that has been applied in many instances and that AT integration is not confined to lecturers and students but to every critical department in the university.

Another significant contribution of the study was the literature on ATs within a disadvantaged university. Much of the existing literature is from the developed world, and the existing frameworks may not be suitable for the university in question.

This study has boldly attempted to contribute three types of knowledge that align with the pragmatic epistemological perspective, namely innovative, revealing, and prescriptive, all categorised as knowledge for action. This knowledge is needed by an educational organisation that seeks to be inclusive by using best practices that promote the integration of ATs. The study revealed that the integration of ATs was taken for granted in the university, and this knowledge was essential in making the actors in the different departments consider many factors when provisioning inclusive education work in fragmented silos. The developed framework contributes to the knowledge for action because it provides the university with alternative systematic ways of harnessing resources to meet the educational needs of students with disabilities.

Finally, the academic contribution bridged the gap in knowledge in AT integration in inclusive education by applying different theoretical perspectives in a disadvantaged rural university. This is the first attempt to address such a real-life problem in which different critical players from different departments have been persuaded to work together for the well-being of students living with disabilities. This study differs from previous studies in that it identifies challenges to AT integration from a broad perspective, making every person in the university responsible instead of focusing on one area. By doing this, it was possible to devise a scientific

solution validated by specialists from different backgrounds, making it relevant and acceptable to the purpose for which it was developed.

9.5. LIMITATIONS OF THE STUDY

A few limitations have been identified during and at the end of the study. These limitations were beyond the researcher's control and might have influenced the study's findings. Some limitations arose from the fact that the study was contextualised to one university, and the centralisation of activities leading to the integration of ATs could have led to other participants having very little knowledge about the ATs. The sample size for qualitative data was minimal, and the findings of such a small sample could have limitations on their applications. Some members who participated in this study, who have little knowledge of other areas being addressed in this study, may not be willing to participate in other areas. AT integration is a specialised area that has implications for those who lack knowledge in education, and the information given could change if they had enough knowledge. The quality of data from different sources could have been distorted somehow.

9.6 RECOMMENDATIONS FOR FUTURE RESEARCH

This study could be conducted longitudinally with more participating universities to give the researcher more time to understand issues and collect adequate data from different participants.

The study made several recommendations.

1. Due to the mismatch between students' needs and the ATs supplied – The study recommends that proper assessment of disabilities for each student should be done by the disability unit at the beginning of each semester to understand the underlying challenges which the provision of ATs can address.
2. Establish a procurement committee, a high-level action plan outlining the requirements for delivering assistive products and services (AT procurement policies) and the time allocation of ATs to needy students.
3. The university must implement a policy that mandates training in ATs for all lecturers in the university and continuous training on AT use for students with disabilities. The service provider can provide training to users on technical aspects of the ATs.
4. The university must implement a proper funding strategy or policy for ATs – reliable funding mechanism that ensures equitable access to ATs to all students in inclusive

classrooms. For example, the universities must move away from asking for monetary donations, and instead, source ATs as per student needs from local and international donors.

5. The university must improve the integration of ATs in inclusive education by having policy-driven, student-centered AT integration and raising strong awareness of the importance of ATs in the university
6. This study aimed to develop a framework for integrating adaptive assistive technology into inclusive education within the disability unit of a historically disadvantaged South African university. Future studies should emphasize the role and impact of the Fourth Industrial Revolution (4IR) and Artificial Intelligence (AI) in advancing inclusive education.
7. Argumentative reality and virtual reality are not being used at the University of Venda hence can not be persuaded for this study, however, this study recommends the university use AI tools to enhance inclusive education

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APPENDICES

Appendix A: UNIVEN Ethical Clearance

ETHICS APPROVAL CERTIFICATE RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Mr V Macheque

STUDENT NO:
11612881

PROJECT TITLE: Integrating adaptive assistive technologies in inclusive education (AATIE): A case study of the disability unit of the University of Venda.

ETHICAL CLEARANCE NO: FMCL/22/BIS/01/1904

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Prof A Kodyamalimba	University of Venda (Business Information system)	Supervisor
Prof NM Ochara	University of Venda (Business Information system)	Co -Supervisor
Mr V Macheque	University of Venda	Investigator – Student

Type: Doctoral Research

Risk: Minimal risk to humans, animals or environment (Category 2)

Approval Period: April 2022 – April 2024

The Research Ethics Social Sciences Committee (RESSC) hereby approves your project as indicated above.


General Conditions

- While the ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:
- The project leader (principal investigator) must report in the prescribed format to the REC:
 - Annually (or as otherwise requested) on the progress of the project, and upon completion of the project
 - Within 48hrs in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
 - Annually a number of projects may be randomly selected for an external audit.
 - The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of those changes at the REC. Would there be deviation from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
 - The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the REC and new approval received before or on the expiry date.
 - In the interest of ethical responsibility, the REC retains the right to:
 - Request access to any information or data at any time during the course or after completion of the project.
 - To ask further questions; Seek additional information; Require further modification or monitor the conduct of your research or the informed consent process.
 - Withhold or postpone approval if:
 - Any unethical principles or practices of the project are revealed or suspected.
 - It becomes apparent that any relevant information was withheld from the REC or that information has been false or misrepresented.
 - The required annual report and reporting of adverse events was not done timely and accurately.
 - New institutional rules, national legislation or international conventions deem it necessary.

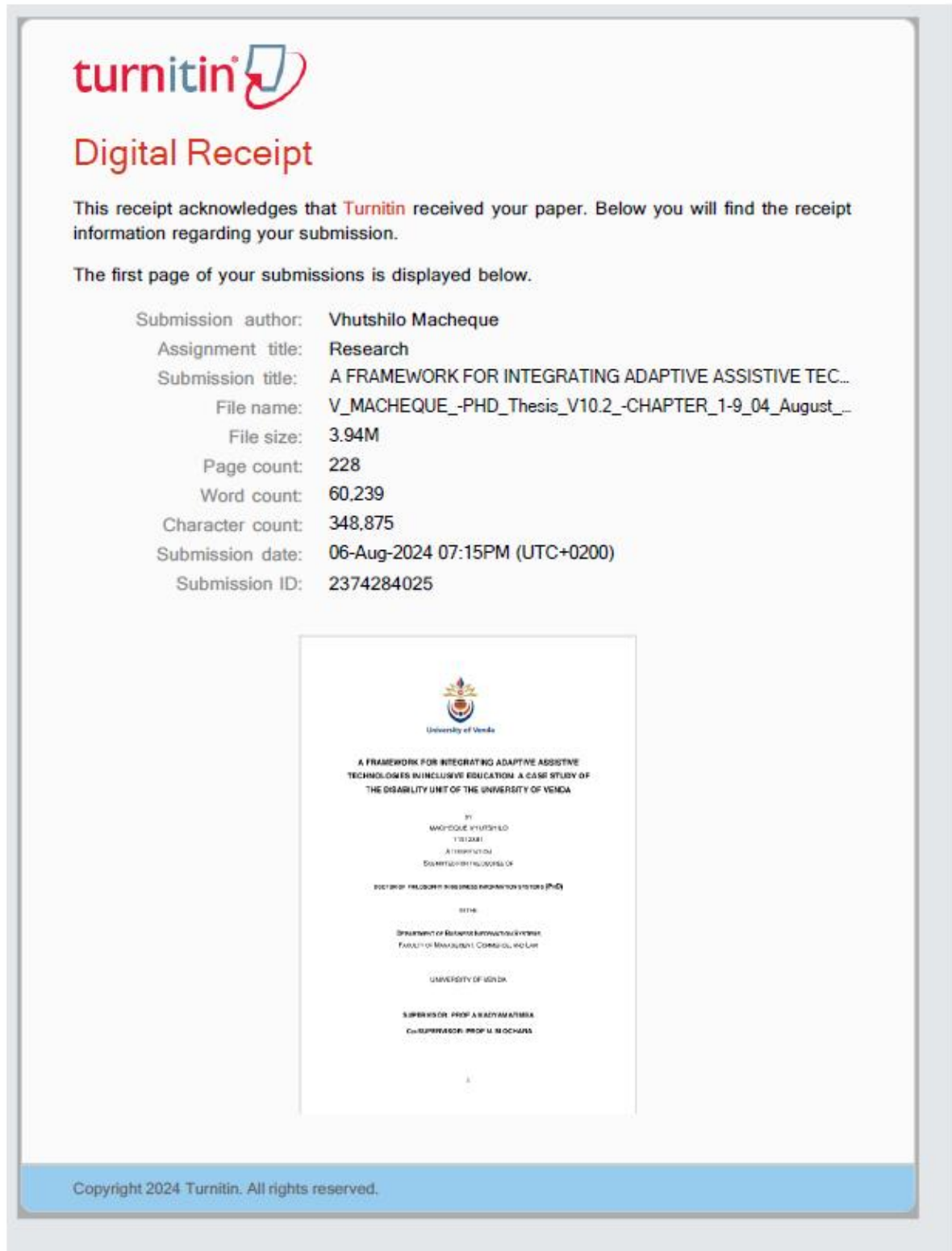
ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE
Date Considered: February 2022

Name of the RESSC Chairperson of the Committee: Prof TS Mashau

Signature




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University of Venda

A FRAMEWORK FOR INTEGRATING ADAPTIVE ASSISTIVE
TECHNOLOGIES IN INCLUSIVE EDUCATION: A CASE STUDY OF
THE DISABILITY UNIT OF THE UNIVERSITY OF VENDA

BY
MACHEQUE VHUTSHILO
11012001

A THESIS
SUBMITTED IN FULFILLMENT OF
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FACULTY OF MANAGEMENT, COMMERCE AND LAW
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Certificate of Editing

This is to certify that the dissertation

A FRAMEWORK FOR INTEGRATING ADAPTIVE
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EDUCATION: A CASE STUDY OF THE
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VENDA

by

VHUTSHILO MACHEQUE

has been proofread and edited for English language
usage.

Date: 7 May 2024

LHugo

Lianne Hugo

Language Practitioner
B.A. (HMS)
PGCE

Appendix D: Informed Consent and Questionnaire for QUAN phase

UNIVERSITY OF VENDA

Dear Respondents

A questionnaire will be used to gather data on the validation of the Integrating Adaptive Assistive Technologies in Inclusive Education framework for disadvantaged universities in South Africa.

I am Vhutshilo Macheque, a PhD student at the University of Venda. I am studying Integrating Adaptive Assistive Technologies in Inclusive Education: A Case Study of The Disability Unit of The University of Venda. I request you complete this questionnaire, which seeks general information about Integrating Adaptive Assistive Technologies in Inclusive Education. The information you provide will be used to validate the proposed framework. It is your right to withdraw from (the study) by answering the questionnaire when you feel like doing so. This questionnaire does not contain any offensive material. No risks, liabilities or benefits are associated with answering this questionnaire and participating in the study. I assure you that all responses will remain confidential as regulated by the University of Venda's ethical policy. Do not write your or your company's name on this questionnaire; your identity must remain confidential. Show your consent by appending your signature in the spaces below. You may contact the researcher at 0780203429 or vhutshilo92@gmail.com or my supervisor, Professor A Kadyamatimba, at Akadyamatimba@univen.ac.za. Or Professor Ochara Nixon. At nixon.ochara@wits.ac.za. Your assistance is greatly appreciated.

Thank you.



_____ **Date:** 2 July 2022

Vhutshilo Macheque

Informed consent statement:

I have read and understood the purpose of the study as outlined in the letter and that I will NOT be rewarded in any form by completing this questionnaire. I voluntarily complete this questionnaire and consent that the information given is, to my best knowledge, on the Integrating Adaptive Assistive Technologies in Inclusive Education framework provided. I permit you to use the information in your study and research papers for publication.

SECTION A: DEMOGRAPHIC INFORMATION AND ATS USER INFORMATION

GENERAL QUESTIONS

1. What is your Level of Studies?.....

- First Year
- Second Year
- 3rd year
- 4th Year
- Honors
- Masters

2. What is the nature of your Disabilities?.....

- Physical disabled
- Chronic Illness
- Partially sightedness
- Partially blind
- Hearing impairment
- Multiple disabilities

3. What is your Gender.....

- Male
- Female
- Others

4. For how long have you been using ATs?.....

- 1 year
- 2 years
- 3years
- 4 years
- 5 Above

5. Source_of_information_of_device

- Institution
- Friends
- Others

6. Do you receive any adapted Technology training?.....

- 1 Yes`
- 2 No

SECTION B: What are the socio-technical challenges faced by students with disabilities in historically disadvantaged universities in South Africa?

1. The question is, how frequently do you use each of these? Range from Every day=5, Twice a week =4, Three days a week = 3, once a week = 2, once month = 1

Assistive Devices	5	4	3	2	1
Text-to-speech / Speech-to-text					
Adjustable monitor arms					
Reading pens					
Alternative keyboards					
Voice recognition					
Digital recorders					
iPads and tablets					
Visual aids, graphic and drawing tools					
Electronic spellcheckers					
Word prediction software					
Visual search engines					
Literacy specific software					
Educational software					
Electronic resources and books					

2. How could the environment be improved to meet your learning needs? Read the supporting statements and rate them from 1 to 5 where (5 = Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly disagree)

Support statements	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The institution delivers assistive devices at the onset of each academic calendar without delay to all deserving students.					
The institution has adequate ATs to support the listening needs of students with disabilities.					
The institution has adequate ATs to support the writing needs of students with disabilities.					
The institution has adequate ATs to support the communication needs of students with disabilities.					
The institution replaces malfunctioning ATs within a reasonable time to cater for the learning needs of students with disabilities.					
ATs in the lecture are easily accessible to all students with disabilities.					

The administration of assistive devices in the institution needs to be improved.					
Buying assistive devices can be improved by involving students with disabilities.					
Delayed allocation of assistive devices is stressful.					
The information centre labs are well-equipped for use by students with disabilities.					
All university buildings are easily accessible to students with disabilities.					
The institution has reliable internet connectivity to meet the learning needs of students with disabilities.					
Lecturers allow students with disabilities to study independently while monitoring them.					
I received appropriate lecturer support on AT to meet my learning needs.					
Training must be provided to our lecturers on supporting a student with disabilities.					
Lecturers understand unique needs and treat students with disabilities with care and love.					
Lecturers who do not understand the needs of disabled students usually overload the students with assignments					
There are enough exceptional mentors and tutors to assist in using ATs for learning purposes.					
There is a need for the institution to employ disabled students in departments to assist students with disabilities.					
Tutors and mentors always get assistive devices on time.					
Students with disabilities have adequate time to use ATs for learning purposes.					
Labs with AT operation times are suitably arranged to suit the needs of students with disabilities.					
Our mentors and tutors are well-trained to assist disabled students in using ATs for learning purposes.					

Continuous training in AT use is provided to students with disabilities.					
All staff members should be trained to work with students living with disabilities.					
Continuous training must be provided to develop staff to teach students with disabilities.					
Lecturers must be trained on how to teach students with disabilities.					

3. Moderating factors: Rate how important each of these factors is in the integration of ATs in inclusive education in the university (Very important, moderately important, Neutral, slightly important, Not at all important)

Moderating factors: Rate how important each factor is in integrating ATs into inclusive education in the university.	Very important = 5	moderately important = 4	Neutral = 3	slightly important = 2	Not at all important = 1
Identifying disabilities among students					
Matching student disability to needs before purchasing or allocating existing ATs					
Having policies on the training of teaching staff on the use/integration of ATs in inclusive education					
Having workshops on ATs with all support staff to raise awareness about the integration into inclusive education					
Having inclusive training programmes for students with disabilities and staff on matters about ATs					
They are allowing students with disabilities to be involved in					

selecting and procuring ATs of their choice.					
Involving parents/guardians of students in the procurement of ATs					
Identifying disabilities among students					
Matching student disability to needs before purchasing or allocating existing ATs					

4. How likely have you used the AT to support each of these activities (Please rank from Very likely - 5 to Very unlikely = 1)

How likely have you used the AT to support each of these activities (Please rank from Very likely - 5 to Very unlikely = 1)	Very Likely = 5	Likely = 4	Not sure = 3	Unlikely = 2	Very Unlikely = 1
Writing in general					
Research					
Mobility					
Hearing					
Reading					
Vision					
Augmentative/ Alternative Communication					
Assisting with learning Disability					

5. To what extent do you agree with these barriers in using AT to support your academic support?

Barriers	Very serious = 3	Not serious = 2	Not sure = 1
Lack of appropriate staff training and support			
Negative staff attitudes			
Inadequate assessment and planning processes			
Insufficient funding			
Difficulties procuring and managing equipment			
Time constraints			

6. Moderating factors: Rate how important each factor is in integrating ATs into inclusive education in the university. **Strategies for Procurement, Training, and Funding: Likert Scale Questions: (•Strongly Disagree - Disagree - Neutral - Agree - Strongly Agree)**

Rate how important each factor is in integrating ATs into inclusive education in the university. Strategies for Procurement, Training, and Funding: Likert Scale Questions: (•Strongly Disagree - Disagree - Neutral - Agree - Strongly Agree)	Strongly Agree)= 5	Agree = 4	neutral= 3	Disagree = 2	Strongly Disagree = 1
Our institution effectively procures appropriate Assistive Technologies for students with diverse needs.					
Training programs for educators and support staff adequately prepare them to utilise ATs effectively.					
Funding mechanisms in place ensure equitable access to ATs for all students in inclusive classrooms.					
There is transparency and accountability in allocating funds for AT procurement and maintenance.					

7. Rate how important each of these factors is in the integration of ATs in inclusive education in the university **Framework for AT Integration: Likert Scale Questions: (Strongly Agree = 5 Agree = 4 neutral= 3 Disagree = 2 Strongly Disagree = 1)**

Rate how important each factor is in integrating ATs into inclusive education in the university. Framework for AT Integration: (•Strongly Disagree - Disagree - Neutral - Agree - Strongly Agree)	Strongly Agree) = 5	Agree = 4	neutral= 3	Disagree = 2	Strongly Disagree = 1
The framework for integrating ATs into inclusive education programs lacks essential components.					
Collaboration among stakeholders significantly contributes to developing and implementing the framework for AT integration.					
Policies and guidelines play a crucial role in supporting the effective integration of ATs while ensuring inclusivity and accessibility for all students.					
Regular evaluations and updates to the framework are necessary to address emerging needs and challenges in AT integration.					

8. Rate how important each factor is in integrating ATs into inclusive education in the university.

Impact and Effectiveness:(Strongly Agree = 5, Agree = 4, neutral= 3, Disagree = 2 Strongly Disagree = 1)

Rate how important these factors are in integrating ATs into inclusive education in the university. Impact and Effectiveness Likert Scale Questions :(Strongly Agree = 5, Agree = 4, neutral= 3, Disagree = 2, Strongly Disagree = 1)	Strongly Agree) = 5	Agree = 4	neutral= 3	Disagree = 2	Strongly Disagree = 1
The integration of ATs has positively impacted the learning experiences of students with disabilities in inclusive classrooms.					
Educators feel confident in implementing ATs effectively to support students with diverse needs.					
The overall academic performance and participation of students with disabilities have improved due to the integration of ATs.					

Moderating factors: Rate how important each factor is in integrating ATs into inclusive education in the university. Challenges and Improvement: Likert Scale Questions Strongly Agree = 5, Agree = 4, neutral= 3, Disagree = 2 Strongly Disagree = 1)

Moderating factors: Rate how important each factor is in integrating ATs into inclusive education in the university. Challenges and Improvement: Likert Scale Questions Strongly Agree = 5, Agree = 4, neutral= 3, Disagree = 2 Strongly Disagree = 1)	Strongly Agree) = 5	Agree = 4	neutral= 3	Disagree = 2	Strongly Disagree = 1
Integrating Assistive Technologies (ATs) in inclusive education settings is straightforward.					
Efforts to improve the integration of ATs in inclusive education settings are effective.					

SECTION C

The technical challenges were assessed using six statements in which respondents were asked to rate themselves on the extent to which each statement their skills compared on a 5-point Likert scale. The scale ranged from 1-5, with one being the lowest and five the highest)

Technical - The skills to use devices and apps to accomplish practical tasks.

- a. To what extent do you understand the characteristics of a device (computer/laptop/tablet)?

1	2	3	4	5
---	---	---	---	---

- b. To what extent can you log into a device and access online content?

1	2	3	4	5
---	---	---	---	---

- c. To what extent do you lose orientation when navigating online?

1	2	3	4	5
---	---	---	---	---

- d. To what extent can you formulate a statement for the search of information online?

1	2	3	4	5
---	---	---	---	---

- e. To what extent do you use the Internet to find and retrieve information from various online sources?

1	2	3	4	5
---	---	---	---	---

- f. To what extent do you use the Internet to organise information so you can find it later?

1	2	3	4	5
---	---	---	---	---

Appendix E: Informed consent form and semi-structured interview schedule

Dear Participant

An unstructured interview schedule will be used to gather data on Integrating Adaptive Assistive Technologies in Inclusive Education: A Case Study of The Disability Unit of The University of Venda.

I am Vhutshilo Macheque, a PhD student at the University of Venda. I am studying Integrating Adaptive Assistive Technologies in Inclusive Education: A Case Study of The Disability Unit of The University of Venda. I am Vhutshilo Macheque, a PhD student at the University of Venda. I am studying Integrating Adaptive Assistive Technologies in Inclusive Education: A Case Study of The Disability Unit of The University of Venda. I am inviting you to participate in this study as an interviewee. Upon getting your consent, ... will ask you questions in an interview, either face-to-face or telephonically. The interview aims to gather general information about Integrating Adaptive Assistive Technologies in Inclusive Education. Your views, beliefs, perceptions, knowledge, and skills in integrating assistive technology in inclusive education are critical in this study. Face-to-face interviews will be conducted at the places and times of your convenience. I seek permission to audio record the interview session to refer to the source during transcription and data analysis. Recordings can always be stopped and erased at your request. It is your right to withdraw from (the study) by answering the questionnaire when you feel like doing so. This questionnaire does not contain any offensive material. No risks, liabilities or benefits are associated with answering this questionnaire and participating in the study. I assure you that all responses will remain confidential as regulated by the University of Venda's ethical policy. Do not write your or your company's name on this questionnaire; your identity must remain confidential. Show your consent by appending your signature in the spaces below. You may contact the researcher at 0780203429 or vhutshilo92@gmail.com or my supervisor, Professor A Kadyamatimba, at Akadyamatimba@univen.ac.za. Or Professor Ochara Nixon. At nixon.ochara@wits.ac.za Your assistance is greatly appreciated.

Thank you.



_____ **Date:** 17 September 2023

Vhutshilo Macheque

Informed consent statement:

I have read and understood the purpose of the study as outlined in the letter and that I will NOT be rewarded in any form by completing this questionnaire. I voluntarily complete this questionnaire and consent that the information given is to my best knowledge of the Integrating Adaptive Assistive Technologies in Inclusive Education framework provided. I permit you to use the information in your study and research papers for publication.

Preliminary interview questions

- Greeting and welcoming the interviewee
 - Explaining the goal of the interview and obtaining informed consent.
 - Ensures the interviewee is comfortable.
 - The interviewer requests permission to videotape the session.
-
1. Tell me briefly about yourself and your role in the disability unit at the university.
 2. How have you contributed to integrating ATs into inclusive education within the university?
 3. What framework for integrating ATs in inclusive education in the university are you familiar with?
 4. What challenges do you face in your work that make it difficult for ATs to integrate into inclusive education?
 5. What effort are you making to overcome the challenges?
 6. What should be done to improve the integration of ATs in inclusive education?

Appendix G: Informed Consent and Questionnaires for IAAITE Framework Validation

UNIVERSITY OF VENDA

Dear Respondents

A questionnaire will be used to gather data on the validation of the Integrating Adaptive Assistive Technologies in Inclusive Education framework for disadvantaged universities in South Africa.

I am Vhutshilo Macheque, a PhD student at the University of Venda. I am studying Integrating Adaptive Assistive Technologies in Inclusive Education: A Case Study of The Disability Unit of The University of Venda. I request you review the framework and checklists provided and then complete the requirements and relevant and acceptable validation questionnaires. Please answer questions using your best knowledge about the relevance and acceptability of the Integrating Adaptive Assistive Technologies framework concerning its use in Inclusive Education. The information you provide will be used to validate the proposed framework.

It is your right to withdraw from (the study) by answering the questionnaire when you feel like doing so. This questionnaire does not contain any offensive material. No risks, liabilities or benefits are associated with answering this questionnaire and participating in the study. I assure you that all responses will remain confidential as regulated by the University of Venda's ethical policy. Do not write your or your company's name on this questionnaire; your identity must remain confidential. Show your consent by appending your signature in the spaces below. You may contact the researcher at 0780203429 or vhutshilo92@gmail.com or my supervisor, Professor A Kadyamatimba, at Akadyamatimba@univen.ac.za. Or Professor Ochara Nixon. At nixon.ochara@wits.ac.za. Your assistance is greatly appreciated.

Thank you.



_____ **Date:** 20 March 2024

Vhutshilo Macheque

Informed consent statement:

I have read and understood the purpose of the study as outlined in the letter and that I will NOT be rewarded in any form by completing this questionnaire. I voluntarily complete this questionnaire and consent that the information given is to my best knowledge of the Integrating Adaptive Assistive Technologies in Inclusive Education framework provided. I permit you to use the information in your study and research papers for publication.

Appendix F: Framework validation questionnaire

This questionnaire consists of three sections:

SECTION 1: DEMOGRAPHIC INFORMATION SECTION 2: RELEVANCE VALIDATION

SECTION 3: ACCEPTANCE VALIDATION.

SECTION A: DEMOGRAPHIC INFORMATION

Please complete this section by checking the spaces provided. (NB check the box as it is automated)

Gender:	Male	<input type="checkbox"/>
	Female	<input type="checkbox"/>
	Others	<input type="checkbox"/>
Age group	Below 20	<input type="checkbox"/>
	20 to 30	<input type="checkbox"/>
	31 to 40	<input type="checkbox"/>
	41 to 50	<input type="checkbox"/>
	Above 50	<input type="checkbox"/>
Highest Academic qualification:	Matric Diploma	<input type="checkbox"/>
	Bachelor's degree	<input type="checkbox"/>
	Honours degree	<input type="checkbox"/>
	Doctorate	<input type="checkbox"/>
Occupation:	Academic Practitioner	<input type="checkbox"/>
	Technology- IT Practitioner	<input type="checkbox"/>

Specialist – Health sector

HOD

Finance or Procurement Manager

Duration in your occupation (years): Less than 2 years

2 to 5 years

5 to 10 years

more than 10 years

SECTION B: VALIDATION OF FRAMEWORK REQUIREMENTS.

Validation of framework requirements				
Dear Experts				
This section of the questionnaire contains five components related to the framework of Integrating Adaptive Assistive Technologies in Inclusive Education and the checklists you are provided with. We need your <i>expert</i> judgment on whether or not each framework component must be included. Your review should be based on the framework provided.				
1= include				
2 = Do not include				
Items	Requirements			
1. components	1	2		
Moderating factors	<input type="checkbox"/>	<input type="checkbox"/>		
ATs procurement strategies	<input type="checkbox"/>	<input type="checkbox"/>		
Training strategies	<input type="checkbox"/>	<input type="checkbox"/>		
Funding strategies	<input type="checkbox"/>	<input type="checkbox"/>		
ATs Integration strategy	<input type="checkbox"/>	<input type="checkbox"/>		

THE VALIDATION OF THE RELEVANCE OF THE COMPONENTS OF THE FRAMEWORK

Validation of Relevance of a Framework for Integrating Adaptive Assistive Technologies in Inclusive Education				
Dear Experts				
<p>This section of the questionnaire contains five components related to the framework for Integrating Adaptive Assistive Technologies in Inclusive Education and the checklists you are provided with. We need your <i>expert</i> judgement on the degree of relevance of each item to measure the suitability of each framework component. Your review should be based on the definitions, relevant components, terminology, and activities provided. Please be objective and constructive in your review and use the following rating scale.</p> <p>Degree of relevance or acceptance</p> <p>1= not relevant</p> <p>2 = relevant</p> <p>3 = quite relevant</p> <p>4 = highly relevant</p>				
Items	Relevance			
1. ATs Moderating factors	1	2	3	4
Moderating factors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ATs procurement strategies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Training strategies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Funding strategies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ATs Integration strategy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SECTION C: FRAMEWORK REQUIREMENTS ACCEPTANCE VALIDATION

Acceptance validation of a framework for Integrating Adaptive Assistive Technologies in Inclusive Education			
<p>The questionnaire contains five sections related to a framework for Integrating Adaptive Assistive Technologies in Inclusive Education and the checklists you are provided with. You are requested to review the framework for its acceptance as a tool for Integrating Adaptive Assistive Technologies in Inclusive Education by Disability and university decision-makers with basic framework skills. Your review should focus on Framework requirements acceptance validation.</p> <p>Please be objective and constructive in your review and use the following rating scale.</p> <p>Degree of acceptability of Integrating Adaptive Assistive Technologies in Inclusive Education Framework in the Universities.</p> <p>3 = highly acceptable 2 = acceptable 1 = not acceptable</p>			
Items validated	Acceptance		
Acceptability of each component of the framework in inclusive education	3	2	1
1. ATs Moderating factors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Moderating factors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ATs procurement strategies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Training strategies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Funding strategies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Please write any comments you think may be valuable in validating the framework.			
Overall validation of a framework for acceptance and usability			

Dear Experts				
This section of the questionnaire contains six components related to the framework of Integrating Adaptive Assistive Technologies in Inclusive Education and the checklists you are provided with—overall validation of a framework for acceptance and usability. Your review should be based on the framework provided.				
1= Yes				
2 = No				
Items				
The language used is suitable.	<input type="checkbox"/>	<input type="checkbox"/>		
Layout is clear	<input type="checkbox"/>	<input type="checkbox"/>		
Components well explained	<input type="checkbox"/>	<input type="checkbox"/>		
Framework is implementable	<input type="checkbox"/>	<input type="checkbox"/>		
The framework is Overall relevance.	<input type="checkbox"/>	<input type="checkbox"/>		
The framework is Overall acceptable.	<input type="checkbox"/>	<input type="checkbox"/>		
Please write any comments you think may be valuable in validating the framework.				

e-mail the completed questionnaire to vhutshilo92@gmail.com, or *WhatsApp to 0780203429*. Thank you for participating in this study.