Exploring Strategies Related to Usability of Assistive Technologies in Implementing Inclusive Education among Visually Impaired Lecturers in Tanzania

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ABSTRACT: *This study focused on exploring strategies related to the Usability of Assistive technologies (Ats) in Implementing Inclusive Education among Visually Impaired Lecturers in Tanzania. The study employed a convergent research design under a mixed research approach guided by the Social Disability Model, Universal Design for Learning Model, and Technology Acceptance Model theories. The study also collected data and information from sixty-seven (67) participants using probability and non-probability sampling techniques. Descriptive and inferential statistical tests are employed for quantitative data, and thematic analysis procedures are used to analyse qualitative information. The study revealed the existence of ATs scarcity due to unclear policies for hiring, inadequate ATs infrastructure, and the expensiveness of ATs. Nevertheless, the study found that there is a lack of ATs at University A, which generalizes the same conditions to other universities in Tanzania. The tested hypothesis indicated there is a relationship between ATs applications for VILs and VIS for effective implementation of a university curriculum. This study concluded that at University A, there are various constraints related to ATs policy availability and application. Subsequently, the study recommended that the responsible organs set clear policies for the universities in Tanzania to adopt ATs, VILs, and VIS as compulsory procedures for their accreditations as full-fledged universities.*

KEYWORDS: assistive technologies, visual impairment, inclusive, curriculum, implementation

INTRODUCTION

The 21st century is characterized by technological applications. In this era of sophisticated skills, assistive technologies (ATs) support the development of skills such as digital literacy, adaptability, communication, collaboration, critical thinking, and problem-solving (Pirzada, 2023). This statement indicates that ATs allow the development and demonstration of the required skills in the education field by visually impaired lecturers (VILs) to effectively navigate education materials and interact with learners (Pramesworo et al., 2023; Murugan, 2023). This statement denotes that the integration of ATs enables VILs to explore pedagogical activities and promote an inclusive and accessible learning environment for both teachers and students.

Adaptability in education is the key element for educators to implement the intended curriculum. Hence, ATs are critical for VILs at the university level to facilitate educational content navigation and mitigate the barriers that VILs may present (Dabi & Golga, 2024; Emara, 2024). People with special needs, particularly the visually impaired ones, depend much on assistive technology devices such as Perkins Braille for meaningful words in the form of raised dots, and other machines that function to facilitate the production of writing for VILs and VIS such as embosser for embossed words. Additionally, with the availability of ATs, there is increased independence for VILs to work independently (Manirajee et al., 2024); expose VILs to advanced communication via different technological tools (Bacalla et al., 2024); facilitate Professional Development acquisition (Alananbeh, 2023); and pave the way to inclusiveness environments for both VILs and visually impaired students (VIS) for effective curriculum implementation (Ngundo & Muriithi, 2023). This compels that ATs are the academic cornerstone for the task accomplishments of VILs and VIS since every plan to be taken into consideration must be integrated with the proper technology.

In this 21st-century era, ATs have proved to be effective for the VILs in the teaching and learning process, leading to the effective implementation of the university curriculum (Muhsin, et al., 2024). The availability and application of ATs for VILs indicate the presence of a curriculum designed to edges; that is, the universal curriculum design for diverse implementers including VILs and Visually Impaired Students (VIS) (Shaheen et al., 2024). This pinpoints the fact that facilitating ATs integration in teaching and for VILs and VIS respectively enables the holistic implementation of an inclusive university curriculum to cater to the needs of every student.

Currently, even with the presence of national policies and international conventions about inclusive design, including education curriculum (Philip, 2024), still, some universities are reluctant to implement inclusive policies and conventions (Rushahu, 2023). This shows that the application of ATs, enrollment of VIS, and employment VILs depend on university policy adherence by the particular university. However, studies show some universities in Tanzania that

practice curriculum inclusiveness such as former Sebastian Kolowa Memorial University (SEKOMU), University of Dar ES Salaam (UDSM), and University of Dodoma (UDOM), VILs are employed, and ATs are fully deployed (Kabogolo & Mubofu, 2023). Consequently, some universities that do not observe curriculum inclusiveness have a low number of employed VILs and enrolled VIS (Sikoyo et al., 2023). This is associated with the reality that when ATs are fully deployed in university curriculum implementation, also the VIS are attracted to join those respective universities being confident of the services provisions. Also, the policies guiding the availability and applications of ATs are crucial for universities to become full practitioners of an inclusive curriculum.

With the support of ATs the university curriculum can be implemented by VILs. Incorporating ATs indicates inclusive curriculum implementation at the university level. Therefore, this study is proposed to explore the possible existing challenges associated with the application of ATs for VILs in teaching and learning processes in respective universities about the effectiveness and the current availability of these ATs for VILs in Tanzania Universities. Finally, the study seeks to come up with an informed meaningful conclusion, discussions, and suggestions on how to holistically design to edges and implement university curriculum inclusively by considering VILs with the deployment of ATs.

Statement of the Problem

Visually impaired individuals need supportive technologies to implement educational duties and excel in their educational ladders. The usability of assistive technologies (ATs) is a critical factor that can influence the successful implementation of inclusive education practices at the university level. Visually impaired lecturers (VILs) in Tanzania face varied challenges in accessing ATs for effective facilitation of inclusive education. Several studies have been focused on the availability of ATs for secondary school students (Malessa, 2023; Hoogerwerf et al., 2021; Manase, 2023; Tahiri, 2023; Ngundo & Muriithi, 2023; and Rushahu, 2023). This connotes that much emphasis has been put on enhancing students' assistive learning devices and leaving behind the most fundamental part of teachers and lecturers who are the facilitators of students' learning. Furthermore, many scholars on ATs adopted either quantitative or qualitative research approaches in which they did not bring an in-depth understanding of the topic. There is a lack of comprehensive strategies tailored to the specific needs and contexts of visually impaired educators in Tanzania. Additionally, there are limited studies about how ATs can be integrated into teaching for VILs (Watermeyer et al., 2023). Therefore it is imperative to carry out the current study to bring a comprehensive understanding of ATs for VILs. Consequently, this study aims to investigate the current availability status of ATs, the existing constraints for ATs usability, explore effective strategies to hire ATs, and propose the best guideline to enhance the usability of ATs among VILs, thereby promoting participatory teaching and active learning for VIS in inclusive education initiatives.

Research Questions

1. What is the availability status of assistive technologies for Visually Impaired Lecturers (VILs) in the curriculum implementation process in universities?

2. What are the constraints related to the usability of assistive technologies for Visually Impaired Lecturers in the curriculum implementation process in universities?

3. What strategies can be used to acquire assistive technologies for Visually Impaired Lecturers and Visually Impaired Students?

Hypothesis

Ha: There is a significant relationship between the application of assistive technologies and the effective implementation of an inclusive curriculum at the university level.

Review of Related Theories

A theoretical framework is a structured set of concepts and ideas that aids in research, explaining phenomena, analyzing data, and drawing conclusions (Smith & Osman, 2023). In this study, three theories of the Social Model of Disability, the Technology Acceptance Model (TAM), and the Universal Design for Learning (UDL) model are used to guide and limit the study.

The Social Model of Disability (SDM). The Social Model of Disability is a perspective that views disability as a result of social, environmental, and attitudinal barriers rather than as an inherent individual limitation (Sedova, 2024) which was introduced in 1983 by the Union of the Physically Impaired Against Segregation (UPIAS) in the United Kingdom; and its leading proponents include dis-abled activists and scholars such as Mike Oliver, Colin Barnes, and Vic Finkelstein (Citron & Fuller, 2024). The strengths of the SMD lie in its focus on social structures and the need for societal change to remove barriers for disabled individuals (Faizefu & Neba, 2024). However, the SMD has been criticized for oversimplifying the complex nature of disability and neglecting the medical interventions for disabled individuals (Azam, 2024). The SMD applies to this study to provide a critical framework for understanding disability as a social construct and guides efforts to create more inclusive and accessible environments for all individuals; specifically a Universal Design for Learning (UDL) which can be reflected in the university curriculum.

Universal Design for Learning (UDL). Universal Design for Learning is an educational framework aiming to provide all students with equal opportunities to learn by offering multiple means of representation, expression, and engagement (Bray et al., 2024). The UDL was

introduced in the 1990s by David Rose and Anne Meyer in the United States to address the variability of learners and promote inclusive education practices (Zhang et al., 2024). The strengths of UDL are the emphasis on flexibility and customization in teaching methods, materials, and assessments to promote accessibility and inclusivity in education by accommodating a wide range of learning styles, preferences, and abilities (Sala-Bars et al., 2024; Fullmer & Strand, 2024). However, UDL is criticized for oversimplification of complex learning tasks and minimising the teacher's roles (Sánchez-Cabrero et al., 2024). The UDL is pertinent to this study as it offers a valuable framework for designing curriculum, instruction, and assessments that cater to diverse learners and promote equitable access to education for all students.

The Technology Acceptance Model (TAM). The Technology Acceptance Model is a theoretical framework that explains how users come to accept and use technology based on their perceptions of its usefulness and ease of use. TAM was introduced in 1986 in the United States by Fred Davis (Cano et al., 2024). The strengths of TAM are based on simplicity and explanatory power in predicting user acceptance of technology (Anggraeni, 2024). However, TAM is criticized due to its focus on individual beliefs and attitudes, overlooking contextual and social factors that may impact technology acceptance in real-world settings (Mukred et al., 2024). The TAM is appropriate to this study for seeking to investigate user behaviour, design user-friendly technologies, and develop strategies to promote technology acceptance and usage.

Review of Empirical Studies
The study reviews existing literature on the availability of assistive technologies for visually impaired lecturers and students, identifying constraints and measures to resolve them. Furthermore, the section synthesizes key findings, identifies gaps in knowledge, and establishes the foundation for further research by identifying gaps in current knowledge and addressing usability issues.

Availability of ATs for VILs and VIS
Improving the availability of assistive technologies for visually impaired individuals including lecturers and students is becoming a global agenda. Finland's government has implemented strategies through specialized organizations like the Finnish Federation of the Visually Impaired (FFVI) and financial support programs (Malessa, 2023). Furthermore, the United States of America has laws like the Americans with Disabilities Act (ADA) mandating equal access to education for individuals with disabilities including visually impaired lecturers and students, and educational institutions often have dedicated disability support services (Hoogerwerf et al., 2021). This shows that ATs accessibility at an individual and institutional level is a primary

advantage to enhancing teaching and learning processes while implementing the intended curriculum at a particular level of education.

Additionally, South Africa has organizations like Blind SA advocating for accessibility and resources, while the government has incorporated assistive technology provisions into educational policies (Manase, 2023). This connotes the importance of legalizing the process of hiring ATs for students and educators to implement an inclusive curriculum. On the other side, Morocco had initiatives promoting inclusive education and enhancing access to assistive devices, however, more resources and training programs are needed (Tahiri, 2023). The statement alerts a need for joint efforts to deal with the availability of ATs about funding, infrastructure and professional development in maximizing the availability and effective utilization of ATs.

In East African countries, especially in Kenya, the government has integrated provisions for assistive devices into its education policies, but limited infrastructure, funding, and awareness persist (Ngundo & Muriithi, 2023). Tanzania's League of the Blind advocates for improved accessibility and support services for visually impaired individuals in Tanzania. The Tanzanian government has also put more initiatives into funding programs related to assistive technology for visually impaired individuals in partnership with other donor countries (Rushahu, 2023). This informs that East African countries are characterized by low budget allocated for education including funding for ATs for individuals with visual impairment thus calling for the reciprocated efforts to advocate for the government to strengthen and effectively implement an inclusive education.

Constraints related to the application of assistive technologies (ATs) for VILs and VIS

In American universities, the ATs for VILs are available with varied limitations such as less familiarity with the real application, most users seeking advantages over disadvantages of ATs application, and the ATs developers lack piloting experience, and also the professional development and/or capacity building for these ATs application is not planned and conducted (Senjam et al., 2021). This indicates the importance of designing edges to make ATs compatible and user-friendly for all users. Additionally, to create the program sustainability, Opoku et al. (2023) suggested conducting training for pre-service teachers and tutors throughout the United Arab Emirates (UAE) on how to use ATs to VIS and VILs to build a technological acceptance culture and integrate those ATs in daily work lifetime. The concept behind these studies is that having pre-requisite knowledge can facilitate the application of ATs in real-life applications in the respective institutions to implement an inclusive curriculum.

Furthermore, it was observed that the parents and families of visually impaired children had negative attitudes towards ATs application to the children which could have effects in later life as those children could become lecturers in respective higher education institutions (Fteiha et al.,

2024). This gives precautions to educators to create an education culture to embrace any newly invented technology to add self-efficacy and value of education inclusively for immediate and long real-life application. In connection to that, Alanazi (2023) pinpointed the importance of conducting special training for both teachers and VIS on how to use ATs in the practical means to bring about meaningful academic and general life to VIS.

In South Africa, it was observed that there was a lack of professional development on how to use ATs for teachers and VIS (Watermeyer et al., 2023). As a result, Pretoria University conducted a multidisciplinary workshop to discuss the creation of inclusive content for VIS and the possible appropriate assistive technologies to be applied to sensitize the importance of the technology adoption by the students and teachers with and without visual impairment (Manis et al., 2024). The study by Al-Sulaimani (2023) in one of the universities in Egypt identified the problem associated with ATs application encountered by VIS, and it was further suggested to use Universal Design for Learning (UDL) so that many VIS may benefit from a holistic approach of learning. In Moroccan universities, the lack of ATs affected the VIS academic performance, and it was suggested to Moroccan policymakers to make considerations for ATs availability to Moroccan University VIS in Morocco (Tahiri, 2023). This denotes that there are some technical challenges related to ATs improvisation that need to be fixed by the education technological device designers.

In Cameroon, the lack of ATs for VIS due to fund constraints led to mass failure in biology subjects for VIS in their respective high schools (Tchombe et al., 2023). Also in Namibia, the study by Mungunda (2023) showed the mass failure of VIS in mathematics resulted from lacking the ATs to VIS that could help in academic content exploration. In Ethiopia, at the University of Hawassa, the VIS lacked the knowledge to use ATs such as Braille Perkins Machines and Computer Assisted Technology (CAT) which was installed in the computer affected the students academically (Mulu & Geta, 2023). This reveals that the application of assistive technology devices is necessary for academic improvement for visually impaired students.

Moreover, the study done by Emara (2024) in Kenya denotes the VIS limitation to pursue university journalism courses due to limited access to ATs, and the same problem was encountered by VILs in Kenyan Universities to teach journalism courses due to the lack of ATs at the particular universities. This leads to the presupposition that the limited availability and application of ATs by the VIS also limits the course choices at the university level, and subsequently, limits the desired choices of the study programs.

In Tanzania, the study by Kisanga and Kisanga (2022) revealed that although the ATs for VIS and VILs were available in respective higher institutions the lack of professional development for users led to continued dependence on respective VIS and VILs to sighted individuals. At the University of Dar Es Salaam in particular, the study by Rushahu (2023) observed that although

the University had VILs employed, Special Education Departments and there were a reasonable number of VIS enrolled, but lacked the timely professional development which brought difficulties for both VILs and VIS to apply ATs in the process of implementing university curriculum. This signifies the power of professional development to revolutionize ATs application leading to absolute academic independence for VIS and VILs to implement an inclusive curriculum at the respective universities. Henceforth, there is a need for the responsible university departments and faculties to conduct respective professional development training to intensify the application of ATs to VILs and VIS in accomplishing the curriculum.

Measures of Resolving Constraints related to the Usability of Assistive Technologies (ATs) for VILs

Due to the limited experience of VILs and VIS in the educational application of ATs and, to create the program sustainability, it was suggested to conduct the training to pre-service teachers and tutors throughout the United Arab Emirates (UAE) on how to use ATs to VIS and VILs to build a technological acceptance culture and integrate those ATs in daily work lifetime (Opoku et al., 2023). Again, due to the negative attitude shown by the parents and some teachers of VIS towards ATs application, it was suggested to conduct special training to enrich the applicability of ATs to both teachers and VIS for effective curriculum implementation at the university level which could later be integrated into real life experience (Alanazi, 2023). This indicates that professional development plays a vital role in internalizing the ATs application confidence as self-efficacy and an internalized trait that is revealed in valuing the available ATs.

In South Africa, especially at Pretoria University; and Egyptian and Moroccan universities it was revealed that there lack of professional development for both VILs and VIS to use ATs (Watermeyer et al., 2023; Al-Sulaimani, 2023; Manis et al., 2024); and to mitigate this problem it was proposed to constantly conduct professional training on how to use ATs to implement university curriculum and advice policymakers to use the Universal Design for Learning (UDL) approach for the holistic methodology of ATs application to both VILs and VIS at the university level (Tahiri, 2023).

In Ghana, the study conducted by Mantey et al. (2023) revealed that universities lacked sufficient policy frameworks to include Visually Impaired Students (VIS) in online learning; and accessibility and usability of digital technology remain challenges. Specialized units for VIS support are also lacking. This is to notify you that the universities need adaptive policies, faculty capacity building, and strategic partnerships with civil society and the private sector to make sure the ATs for VILs and VIS are intensively adopted in the university curriculum implementation process.

In Ugandan universities, students with visual impairments face challenges in interaction, inadequate learning support, and inaccessible information lacking motivation to use ATs for general academic activities. Promoting inclusive education successfully should focus on the practical use of ATs, adjusting physical, social, and learning environments, as well as improving counselling services to address social and psychological issues (Kija & Mgumba, 2024). This statement is linked to the Social Disability Model which sees disability as a social construct, and once this barrier is removed by mitigating negative attitudes and creating an accessible society, all individuals with special needs, especially the visually impaired ones, the respective individual will be free to accomplish their required tasks including an inclusive curriculum.

The study by Munala and Mwendo (2023) revealed the weakness of ATs adoptions among education institutions ranging from primary schools to university VIS and suggests that public elementary schools in Nairobi County should adapt educational examinations for students with disabilities by incorporating accommodations like assistive technologies, additional time, magnified print, sign language, scribe employment, alternative examination processes, and timing. This statement invites educators to think of alternative assessments that can align with the available ATs to have diverse curriculum implementation methods.

The study by Oketoobo et al. (2023) in Tanzania showed that teachers play a crucial role in assessing, evaluating, and implementing educational strategies for visually impaired students, and unfortunately, these teachers lack ATs to facilitate VIS, hence it is recommended to the government to increase funding and enrich curriculum content for holistic implementation. The statement seeks to console the fundamental teacher leadership in implementing an inclusive curriculum. Consequently, before ATs application the teachers should be the priority to receive capacity building so they can assist students in applying respective assistive devices.

RESEARCH METHODOLOGY

This section aims to present the methodology of the study with a focus on research philosophy, research design, target population, sampling techniques and sample size, research instruments, validity of instruments, reliability of instruments, data collection procedure, data analysis, and ethical considerations.

This study deployed the convergent design under a mixed research approach that is based on a pragmatic research philosophy to gather quantitative and qualitative data in one of the sampled universities in the Morogoro region. This philosophy provides a set of beliefs, assumptions, and principles that guide the conduct of research (Kasirye, 2024). The pragmatic research philosophy emphasizes the practical application of research findings and a flexible, problem-solving approach that prioritizes real-world relevance and effectiveness (Tamminen & Poucher, 2020;

Kelly & Cordeiro, 2020) to offer a framework for conducting research that is responsive to the contemporary practical world (Gillespie et al., 2024). Research design enhances the strategy for responding to the research question using empirical data.

The population of this study was all VILs from Tanzania universities, and the sample size was determined by snowball techniques. Consequently, a target population includes all people to participate in a study, whereas the sample is a part of the population (Tamminen & Poucher, 2020). The sampling procedure is a practical way that allows data to be collected quickly and at a lower cost than attempting to reach every member of the population (Solem, 2023). The sampling of this study was drawn from the study area by using the snowball technique. Description of data collection instruments included the consultation with the dean of students from respective universities to seek permission to conduct the study. The questionnaires and interview guide were used to collect both qualitative and quantitative data from VILs and VIS.

The validity and reliability of data collection instruments will be regarded. A *pilot study* was conducted before the actual data collection to test the validity and reliability of research tools, as it is regarded as practical and optimal (Gümüş & Kukul, 2023). The test-retest approach was used to measure the reliability of quantitative data collection instruments; and for the qualitative data collection instruments prepared for this study, pilot data collection and analysis helped to ensure the trustworthiness of the instruments. Description of data analysis procedures included quantitative analysis by using statistical tools such as Statistical Package for Social Sciences (SPSS) to examine the relationships between ATs and inclusive curriculum implementation practices whereas descriptive statistics was used to summarize and analyze quantitative data. Qualitative Analysis, on the other hand, used thematic analysis for qualitative data obtained from interview guides and questionnaires to identify patterns and themes related to the adoption of ATs to VILs in inclusive curriculum implementation processes. Ethical considerations in this study included obtaining informed consent from VILs before collecting data, and to ensure confidentiality and anonymity in reporting and storing data; adhering to ethical guidelines, and obtaining approval from Jordan University College (JUCo) ethical review board.

FINDINGS AND DISCUSSIONS

The study had three questions that sought to explore the availability and usability of assistive technologies (ATs) for Visually Impaired Lecturers (VILs) in the university curriculum implementation, identify constraints related to their usability, and suggest strategies for acquiring ATs for VILs and VIS respectively. To guide and limit the study, three theories of the Social Mode of Disability, the Technology Acceptance Mode (TAM), and the Universal Design for Learning (UDL) were used. This research had sixty-seven (67) respondents, deploying interview guides and questionnaires as data collection tools; and snowball and purposive sampling as

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sampling techniques. The research generated information from 1 Vice-Chancellor (VC) from University 'A', 1 Head of Department (HoD) of Psychology from University 'A', 1 VIL from University 'A', 1 VIS, and 63 non-VIS students from University 'A', to investigate the current state of availability and usability, related ATs' constraints on usability, and suggested the best strategies for acquiring and maintenance of ATs for VILs and VIS. The interview guide was deployed to get information from VC, Psychology HoD, VILs, and VIS. The questionnaires were used to generate information from non-visually impaired students. The information was presented in the tabular form labeled – ATs: Availability; ATs: Constraints and; ATs: Strategies as per research questions respectively. Table 1 presents responses from non–visually impaired students about ATs' availability from sampled Universities.

Table 1: Students' Responses to ATs Availability (n=63)

S/N	STATEMENTS	Responses (%)						
		SD	D	U	A	SA	MEAN	SDV
1	Availability of Laptop at the university for Visually Impaired Students (VIS) and Visually Impaired Lecturers (VILs)	19.0	19.0	3.2	38.1	20.6	3.22	1.464
2	Applicability of Recording devices at the university for VILs and VIS	12.7	15.9	12.7	42.9	15.9	3.33	1.283
3	Availability and application of Perkins Braille Machine for VILs and VIS	14.3	14.3	22.2	36.5	12.7	3.19	1.255
4	Availability and application of A4 Frames and slates	9.5	14.3	22.2	36.5	17.5	3.38	1.211
5	Availability of Brailled Curriculum Materials for VIS	7.9	19	31.7	23.8	17.5	3.24	1.187
6	The university should have a special education unit	1.6	1.6	7.9	25.4	63.5	4.48	0.840
7	Assistive Technologies support Visually Impaired Students in learning	0	0	7.9	31.7	60.3	4.52	0.644
8	Assistive Technologies help Visually Impaired Lecturers to teach well	0	0	7.9	27	65.1	4.57	0.640
9	The university should purchase Assistive Technologies for VILs and VIS	0	1.6	7.9	30.2	60.3	4.49	0.716
10	Do you cooperate with Visually Impaired Lecturers in the use of Assistive Technologies?	1.6	3.2	9.5	41.3	44.4	4.24	0.875

Key: 1. SD – Strongly Disagree   2. D – Disagree 3.   U – Undecided 4. A - Agree   5. SA – Strongly Agree
Source: Field Data (2024)

Data in Table 1 indicates that the majority (82.1%) of respondents agreed and strongly agreed that assistive technologies help visually impaired lecturers to teach well with a mean score of 4.57. this denotes that assistive technologies have contributed to lecturers in the process of implementing curriculum inclusively. This finding correlates with Malessa (2023) who claimed that there is a need for joint efforts to make sure the ATs are available for visually impaired

individuals including VILs and VIS to increase access to various life affairs such as education services. This claim was also supported by information given by VC A that; ATs contribute significantly to curriculum implementation when adopted by VILs and VIS, and that the Psychology Department was assigned to deal with respective gadgets:

> *"We are planning to develop a Special Education Unit with a well-equipped resource room to deal with a variety of special education needs including visually impaired students and lecturers. I have assigned the Department of Psychology to deal with ATs and their all related issues. The department deals with availability, maintenance, and professional development about ATs application" (VC A, Personal communication, 30th April, 2024).*

This finding is contrary to the theory of Universal Design for Learning (UDL) which emphasizes flexibility and customization in teaching methods, materials, and assessments to promote accessibility and inclusivity in education by accommodating a wide range of learning styles, preferences, and abilities (Sala-Bars et al., 2024; Fullmer & Strand, 2024). This result denotes that there is a need for increased applicability of ATs for VILs and VIS for effective curriculum-inclusive implementation in Tanzanian universities.

Again, statistics in Table 1 display an extreme majority (88.9%) of respondents who proposed the respective university take the obligation to develop a special education unit, consult donors, and, buy assistive technology devices for VILs and VIS for the sake of inclusive curriculum implementation at the university level. This result is linked to the study by Manis et al. (2024) and Tahiri (2023) indicating that the universities have a responsibility to make sure there are available ATs at the university level. This claim was reinforced by information given by Psychology HoD of University 'A' who revealed the efforts made by the university to hire ATs, specifically Orbiter Reader, Voice Recorder, and specialized computers for VILs and VIS from respective university: *"There are voice recorders and Orbiter 45 for VILs and VIS which were obtained by the individual department members from different donors. The VIS uses university computers installed with specialized voice software called jaws"* (*Psychology HoD personal communication, 30th April, 2024*). This result villains the awareness of universities to implement curricula inclusively by showing readiness for aligning with Tanzania's national policy and international conventions for educational inclusiveness. This finding is supported by the Universal Design for Learning (UDL) framework which proposes the provision of all students with equal opportunities to learn by offering multiple means of representation, expression, and engagement (Bray et al., 2024) and promoting inclusive education practices (Zhang et al., 2024). The finding indicates that the ready availability of ATs at the university level paves the way to implement an inclusive curriculum that favours all learners, and enables VILs to have effective multiple means of teaching and interacting with their students.

Furthermore, collaboration between VILs and non-VILs in the process of using ATs is a key element in strengthening inclusive curriculum implementation. The same Table shows that the extreme majority (85.7%) of respondents revealed the collaborative strategies initiated among VILs, VIS, lecturers, and students. This finding is coherent with the study by Hoogerwerf et al. (2021) who claimed that collaboration is the notable feature of an inclusive community to embrace human diversities including visually impaired individuals such as VILs and VIS. This inclusive culture statement is justified by the information given by VILs A who claimed to collaborate with their colleagues in the process of using ATs in teaching:

> *"In most cases, I get support from my staff members as they collaborate with me in every activity related to the ATs applications, as I do not have any experience, since I acquired visual impairment later in life, and have not yet decided to use ATs. I am not prepared psychologically to use ATs"* (VIL A, Personal communication, 30th April, 2024).

Moreover, the collaboration statement was stressed by VIS who claimed to collaborate with the peers in the process of using ATs in learning: *"I bought some of the ATs such as A4 Frames and Stylus. The psychology department bought me a voice recorder; I use university computers for my daily studies and examinations. My fellow students help me to surf the internet reading materials"* (*VIS personal communication, 30th April, 2024*). This finding is harmonious with the Social Model of Disability (SDM) which holds a perspective that viewing disability as a result of social, environmental, and attitudinal barriers rather than as an inherent individual limitation and calls for a social perspective adjustment to enable individuals with disabilities to explore the environment safely (Sedova, 2024). It further suggests focusing on social structures and the need for societal change to remove barriers for disabled individuals (Faizefu & Neba, (2024). The implicative feature of this finding relies on the truth that, among other advantages of ATs to enhance 21st-century skills including collaboration, insisting the joint efforts for accessible society by ensuring the availability and application of ATs for the practical existence of collaborative culture in using ATs at the respective university.

Table 2 presents data generated from non–visually impaired students about ATs' usability constraints from University A. The question dealt with the constraints related to the application of assistive technologies (ATs) for VILs and VIS. The following table summarizes the collected responses.

Table 2: ATs - Students Response on ATs Constraints (n=63)

S/N	STATEMENTS	Responses						
		SD	D	U	A	SA	MEAN	SDV
1	Lecturers face challenges in teaching using assistive technology	6.3	17.5	25.4	39.7	11.1	3.32	1.090
2	Students face challenges in learning by using assistive technology	7.9	27	30.2	27	7.9	3.00	1.092
3	The department deals with ATs maintenance	3.2	6.3	17.5	46	27	3.87	0.992
4	Lack of professional development on how to use ATs	6.3	9.5	23.8	36.5	23.8	3.62	1.142
5	Lack of special education unit for VILs and VIS	7.9	11.1	12.7	38.1	30.2	3.71	1.237
6	Assistive Technologies are expensive	3.2	4.8	22.2	47.6	22.2	3.81	0.948
7	There are no brailed teaching and learning materials	6.3	17.5	19	39.7	17.5	3.44	1.161
8	There are no Perkins machines at the university	11.1	20.6	22.2	23.8	22.2	3.25	1.319
9	Lack of visual impairment experts	3.2	20.6	14.3	39.7	22.2	3.57	1.146
10	Lack of willingness to learn new technology	9.5	28.6	28.6	20.6	12.7	2.98	1.184

Key: 1. SD – Strongly Disagree   2. D – Disagree 3.   U – Undecided 4. A - Agree   5. SA – Strongly Agree
Source: Field Data (2024)

Figures in Table 2 indicate almost half (57.15%) of respondents rated the existence of a limited number of ATs for VILs and VIS which hinder the process of teaching and learning respectively at the university as 'A'. This entails the prevailing of a limited number of ATs devices for supporting VIS in their teaching and learning environment. This may also imply VIS individuals are struggling to effectively pursue education in higher learning institutions. These findings denote that ATs devices are expensive for every VIS to hire and possess for academic success. This finding is related to Mantey et al. (2023) and Tahiri (2023) who pointed out challenges faced by VILs and VIS due to limited funding and awareness about   ATs. This designates there is an   inadequate   number   of   ATs   at   the university which impedes the implementation of an inclusive curriculum. This conflicts with the UDL theory which contains about readily availability of curriculum materials to suit and enable learners from diverse backgrounds and abilities to access education at minimal restrictions (Bray et al., 2024). This avowal is aligned with VIS A statement about ATs scarcity at the university

level: *"There is a lack of embossed learning materials, and many university computers are not installed with jaws sound software, and sometimes when the electricity goes off the examinations are lost as many computers are desktops" (VIS A, Personal Communication, 30th April, 2024).* This surmises the scarceness of ATs at the university not only affects learning, but also affects the assessment and evaluation processes, and reveals the side effects of Computer Assisted Assessments (CAA) in unreliable electricity. This finding was also confirmed by VC A who claimed that:

> *"We have a few numbers of VILs and VIS at our university. We also lack some potential ATs to fully enable our clients and normally contact different donors to help with these respective gadgets. We still ask well-wishers to support ATS gadgets for our VILs and VIS at our university" (VC A, Personal Communication, 30ᵗʰ April, 2024).*

The information from VC signposts the existence of ATs availability challenges and the continuous efforts to mitigate the scarcity. The findings from VC correspond to the Technology Acceptance Model (TAM) which explains how users come to accept and use technology based on their perceptions of its usefulness, ease of use, and readily available (Cano et al., 2024). This result informs the existence of availability challenges related to funding and awareness about ATs for VILs and VIS among the universities in Tanzania which calls attention to all universities, respective authorities, and other stakeholders to take reasonable measures to rescue the existing situation.

Furthermore, from Table 2, data shows almost half (59%) of respondents revealed the importance of the provision of professional development and expertise to VILs and VIS to effectively adoption of ATs in teaching and learning at the university level. The studies by Alananbeh (2023), Alanazi (2023), Opoku et al. (2023), Senjam et al. (2021), and Watermeyer et al. (2023) pinpointed the importance of conducting training for both VILs and VIS on how to effectively deploy ATs in teaching and learning respectively in their respective universities. Corresponding to the importance of the provision of professional development and expertise, the VILs A advocated that:

> *"I have not attended any professional development course related to ATs application, so I don't have any experience with challenges related to the use of ATs. However, due to my experience, and that of my visually impaired student, this university is a better place for VIS and VILs as there are smooth paths, reachable classes and collaboration among the university community" VILs A, Personal communication,30ᵗʰ April, 2024).*

The statement from VILs signifies the importance of professional development to enable independent curriculum exploration. Connected to this idea, also information from Psychology

HoD showed the importance of professional development training to both VILs and VIS by taking the leading example of attending the workshop conducted by the joint universities on how to use ATs academically to VILs and VIS: *"There are different efforts made to hire ATs for the university VILs and VIS and attend the professional development prepared by the collaboration of zonal universities on how to use these available gadgets..."* (*Psychology HoD, Personal communication, 30th April 2024*). The TAM is compatible and applicable to this study since it seeks to investigate user behaviour, design user-friendly technologies, and develop strategies to promote technology acceptance and willingness to use (Mukred et al., 2024). This finding implies that professional development related to ATs applications for VILs and VIS is important since there are frequently newly invented gadgets with updated features requiring training.

Statistics in Table 3 indicate the generated from Non–Visually Impaired Students regarding the best way to hire, use, and maintain the ATs for VILs and VIS at the university level. The question dealt with the practical strategies for the availability of assistive technologies (ATs) for VILs and VIS. The following table summarizes the collected responses.

Table 3: ATs - Students Response on ATs Strategies (n=63)

S/N	STATEMENTS	Responses						
		SD	D	U	A	SA	MEAN	SDV
1	Lecturers buy assistive technology devices	9.5	17.5	19	41.3	12.7	3.30	1.186
2	Students seek donors for assistive technologies	3.2	9.5	17.5	54	15.9	3.70	0.961
3	The department deals with ATs maintenance	0	7.9	20.6	57.1	14.3	3.78	0.792
4	Professional development on how to use ATs	1.6	3.2	7.9	44.4	42.9	4.24	0.856
5	Special education unit for VILs and VIS	1.6	1.6	4.8	42.9	49.2	4.37	0.789
6	University buy Assistive Technologies devices	1.6	3.2	7.9	38.1	49.2	4.30	0.873
7	Brailed teaching and learning materials	1.6	0	7.9	47.6	42.9	4.30	0.754
8	Perkins machines at the university	0	6.3	4.8	41.3	47.6	4.30	0.835
9	University employs visual impairment experts	1.6	1.6	7.9	25.4	63.5	4.48	0.840
10	Families contribute to Assistive Technology devices	4.8	6.3	17.5	44.4	27	3.83	1.056

Key: 1. SD – Strongly Disagree   2. D – Disagree 3.   U – Undecided 4. A - Agree   5. SA – Strongly Agree

Source: Field Data (2024)

From Table 3, data shows the majority (80.2%) of respondents proposed the development of a Special Education Department (SED) to deal with maintenance, availability of embossed materials, and availability of ATs such as Perkins and embosser machines for VILs and VIS. The SED is expected to conduct professional development on how to use ATs for VILs and VIS and

suggest the university employ visual impairment experts. This SED was also expected to organize Non-governmental organisations (NGOs), different donors, and individuals to buy ATs for the intended VILs and VIS at the respective universities. This finding was supported by the study of Malessa (2023) who suggested the respective education institutions including universities to seek ATs through specialized organizations, to incorporate financial support programs, and advised the governments of respective countries to incorporate assistive technology provisions into educational policies. Moreover, Ngundo and Muriithi (2023) advocated for the increased rise of awareness about visual impairment needs in education and create an inclusive culture in which no student is left behind. The finding also was supported by the information given by one of the university administrators (VC A) who described a statement on how to reduce the effects of ATs scarcity: *"We are planning to develop a Special Education Unit with well-equipped resource room to deal with a variety of special education needs including visually impaired students and lecturers" (VC A, Personal Communication, 30th April, 2024).*

Again, this finding was also supported by the Social Model of Disability (SDM) which focuses on social structures and the need for societal change to remove barriers for disabled individuals (Faizefu & Neba, (2024). In addition, the Universal Design for Learning (UDL) theory emphasizes flexibility and customization in teaching methods, materials, and assessments to promote accessibility and inclusivity in education by accommodating a wide range of learning styles, preferences, and abilities (Sala-Bars et al., 2024; and Fullmer & Strand, 2024). Therefore, the SDM and UDL theories apply to this study since they inform society and provide the education stakeholders with a valuable framework for designing curriculum, instruction, and assessments that cater to diverse learners and promote equitable access to education for all students including VILs and VIS at the respective universities.

Additionally, this finding about strategies on how to hire and maximize the application of ATs calls for a holistic approach in education matters as indicated in education for sustainable development goal 4 (SDG 4) within three components of sustainable development namely environment, society, and economy (Singh, 2017). Sustainable Development Goal 4 (SDG 4) is one of the 17 Sustainable Development Goals adopted by the United Nations in 2015 as a part of the 2030 Agenda for Sustainable Development. It aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (The United Republic of Tanzania, 2020). Furthermore, education is seen as essential for sustainable development (Singh, 2017) and can help people lift themselves out of poverty, improve their health and well-being, and participate fully in society (Manea et al., 2015). Education can also help to promote peace and understanding between different cultures (Dupuy, 2021; Rufadha & Younis, 2023). SDG 4 indicates that education is an agent of decent life, so it should be the right of every individual and

should be accessible to everyone. Hence, the ATs for VILs and VIS are the stepping stones to an inclusive curriculum of education benefiting all people with different abilities and backgrounds.

To establish the relationship between the application of ATs by VILs and the effective implementation of an inclusive university curriculum, a simple linear regression statistical technique was used to test the Null Hypothesis (H0), which stated that there is no significant relationship between the application of ATs and the effective implementation of an inclusive university curriculum in at university level in Tanzania. The establishment of the decision rule was done at a significant level of 0.05 (2-tailed), guided by assumptions of normal distribution of data with no significant outliers. The tested output is displayed in Table 4

Table 4: Hypothesis test ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	.328	2	.164	2.019	.203[b]
1	Residual	.569	7	.081		
	Total	.897	9			

a. Dependent Variable: ATs: Effective implementation of an inclusive university curriculum
b. Predictors: (Constant), Application of ATs by VILs

From Table 4, the data shows the p-value of the statistical test was 0.203 at a significance level of 0.05. This indicates that a P-value is greater than the significance level of 0.05; therefore the statement of the hypothesis was accepted as there is no significant relationship between the application of ATs by VILs and the. This denotes that, critical efforts are needed to increase the availability and application strategies of ATs by the VILs at the universities levels in Tanzania. The data may also indicate the limited awareness and existence of autonomy of university curriculum done by the respective universities which restrict the actual deployment of intended technology designation. However, the curriculum design autonomy, on the other hand, can be a great opportunity for planning and improvising as many ATs as possible for both VILs and VIS. The availability and application of ATs at the university level relates to the UDL theory which emphasizes flexibility and customization in teaching methods, materials, and assessments to promote accessibility and inclusivity in education by accommodating a wide range of learning styles, preferences, and abilities.

CONCLUSIONS AND RECOMMENDATIONS.

This section presents the conclusions drawn from the study findings, recommendations, and suggestions for further research.

Conclusions of the Study

Regarding the availability of ATs for VILs and VIS in implementing an inclusive curriculum at the university level, the majority of respondents revealed that there were availability of some of the technological gadgets but were insufficient for the users, and were not in a complete set (Embosser, Perkins Braille, A4 Frames, Stylus, and Braille Papers) and lacked proper professional development.

Several challenges were faced by VILs and VIS in the process of utilizing ATs for teaching and learning respectively. The VILs lacked proper ATs professional development as one of the VILs was not ready psychologically to undergo the aforementioned training with the claim that one acquired visual impairment later in life. So, it is noticed that individual who acquire visual impairment later in life struggle more to adopt ATs than those who are congenitally or who acquire visual impairment at the early stages of their lifetime. Expensiveness and inadequate infrastructure were also noticeable challenges. The gadgets such as embosser, Perkins Braille machines, and Orbit Reader are more expensive compared to other gadgets like screen magnifiers and other eye-sight rectifying glasses. University computers were mostly desktops that depended solely on electricity, and once the power went off all the VILs and VIS activities via those respective desktops also disappeared.

Concerning the measures to take to assure the availability and application intensification of ATs, University A administrators pointed out several collaborative strategies and measures to go about mitigating the existing challenges. University A committed itself to launching the Special Education Department which would deal with hiring and adoption of ATs for VILs and VIS to ensure an inclusive curriculum is implemented. Other measures were policy formulation for ATs application to VILs and VIS, buying ATs, consulting different local and international donors, and providing regular professional development for using ATs.

Recommendations of the Study

The following recommendations are given in reaction to the conclusions of the study:

1. Since education is a core human right, it is recommended that each university should have a clear policy regarding the availability of ATs for VILs and VIS in implementing an inclusive curriculum at the university level.

2. Due to various existing challenges related to ATs availability and application, it is recommended that every university should have a clear policy to establish a special education department with respective experts to deal with teaching and learning issues for VILs and VIS respectively.

3. Since inclusive education is a contemporary society, it is recommended that the responsible organs for university establishments such as the Tanzania Commission for Universities (TCU), and the Ministry of Education, Science and Technology should accredit the university based on education inclusivity features of a particular university.

4. Since ATs are expensive, the study recommends that the government allocate grants for the VILs and undergraduate and postgraduate VIS to reduce the challenges of accessing complex technological equipment.

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