ICT ACCESSIBILITY SOLUTIONS TO PERSONS WITH VISUAL IMPAIRMENT AT THE OPEN UNIVERSITY OF TANZANIA

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CERTIFICATION

The undersigned certifies he has read and hereby is recommended for acceptance by the Open University of Tanzania a dissertation entitled “ICT accessibility Solutions to persons with visual impairment at the Open University of Tanzania” in fulfillment of the requirement for a Master of Science in Information Communication Technologies of the Open University of Tanzania.

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Date

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DECLARATION

I, **Said Ramadhani Said**, do hereby declare that the report on the ICT accessibility solution to persons with visual impairment at the Open University of Tanzania is my own original work. This work has not been presented and will not be presented to any other University in a similar or any other degree award. All the sources I have used or quoted have been indicated and acknowledged.

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Signature

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Date

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ABSTRACT

This study had the main purpose of designing and implementing new solutions for ICT accessibility to persons with visual impairment at the Open University of Tanzania (OUT). A sample of 50 respondents, 36 sighted and 14 visually impaired persons participated in the study. Of the 36 sighted persons, 8 were system administrators, 8 ICT instructors, 10 Management officials and 10 were ICT students at OUT. All 14 Persons with Visual Impairement (PwVI) are either students or staff. The study was descriptive in nature, employing questionnaire, interview, observation and document review as data collection tools. The findings of the study indicate that, for visually impaired problems to accessibility were related to unavailability of ICT training opportunity and inaccessibility of online content. To measure the accessibility of the online content, Achecker tool was used. It was found that most of the ICT related solutions for ICT accessibility problems are provided by an international standard organization called World Wide Web Consortium (W3C). However, none of the System administrator at OUT had the skills to incorporate W3C in developing accessible online content, resulting to visually impaired persons having inaccessible developed support systems. In this study, it was also possible to design and implement two general solutions that can be used to solve many accessibility solutions. This study has also provided frameworks at the institutional level as well as at the technical level on how to improve ICT accessibility for persons with visually impaired.

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LIST OF ABBREVIATIONS

CCBRT	Comprehensive Community Based Rehabilitation in Tanzania
CD – ROM	Compact Disc Read Only Memory
DSS	Decision Support System
GUI	Graphical User Interface
HCI	Human Computer Interaction
HTML	Hypertext Markup Language
ICT	Information and Communication Technology
IDP	Innovation Diffusion Process
IT	Information Technology
LMS	Learning Management System
MIS	Management Information System
MOODLE	Modular Object-Oriented Dynamic Learning Enviroment
MVC	Model View Controller
NICHCY	National Dissemination Center for Children with Disabilities
NICTP	National ICT Policy
NPD	National Policy on Disability
OUT	Open University of Tanzania
PC	Personal Computer
PDA	Personal Digital Assistant
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
PwVI	Persons with Visual Impairement
TAM	Technology Acceptance Model

URT	United Republic of Tanzania
VI	Visual Impairment
W3C	World Wide Web Consortium (W3C)
WHO	World Health Organization
WIMP	Windows, Icons, Menus and Pointers

CHAPTER ONE

1.0 INTRODUCTION

This chapter presents background information on Information and Communication Technologies (ICT) in education. This chapter also presents the use of ICT to improve the quality of education as well as ICT accessibility issues for persons with visual impairment (PwVI) enrolled at The Open University of Tanzania (OUT). This will be followed by the problem discussion, resulting in an overall purpose of the research, and specific research questions. The significance of the study will also be discussed.

1.1 Background to the Study

ICT has been viewed as an important agent in teaching and learning (Mikre, 2011; UNESCO, 2011; Soby, 2013). Though ICT is having a powerful influence in teaching and learning, persons with disabilities, including the visually impaired persons face barriers related to ICT accessibility and hence fail in accessing ICT services (Balanskat *et al*., 2006; Rhema, Amal & Iwona, 2009; Bingimlas, 2009; Seale, 2013. And in particular those who enroll in open and distance learning at the Open University of Tanzania (Newa, 2012; Mnyanyi & Mbwette, 2009; Mnyanyi, 2012). These challenges if not addressed might lead to the total isolation of persons with disabilities in the general society development agenda with a focus on ICT usage.

It is important to note that persons with disabilities have the right to education. The question is how they will access education in the era of science and technology

where ICTs are making major differences in the learning and teaching approaches (Mikre, 2011). The main advantages of ICT usage in the teaching and learning process are based on the possibilities it offers for alternative means of communication, providing access to educational resources in a more convenient way and to enhance learning motivation (UNESCO, 2011). At the Open University of Tanzania (OUT) persons with disabilities started being enrolled in 1997 (Bagandanshwa, 2000). ICT has become a tool for enhancing teaching and learning at OUT (Mnyanyi & Mbwette, 2009). However, Newa show that with the use of ICT many people in society have faced challenges related to accessibility and usability of ICTs (Newa, 2012). More of those challenges are faced by persons with disabilities, especially those with visual impairment (Mnyanyi & Mbwette, 2009). Therefore disabled population is denied from full and equal access to ICT, as most ICTs are designed with no consideration for the disabled persons (WHO, 2010). With this in mind, there is a dare need of establishing the ICT accessibility needs of disabled people at OUT and thereafter analyse the practical IT solution that would enhance the ICT accessibility in general.

1.1.1 Importance of ICT in Education

ICTs are rolling out dynamic improvements in the public eye; they are impacting all parts of life. The impacts are more significant in learning and teaching environments. Because ICTs provides both students and teachers with more opportunities in adapting learning and teaching to individual needs, society is forcing schools appropriately to respond to this technical innovation (Soby, 2013). Soby, states the possibilities of ICTs in expanding and enhancing significance and nature of teaching

and learning in developing countries (Soby, 2013). This is an adequate explanation behind the use of ICTs to win overall acknowledgment and consideration in transforming the way education is delivered. For instance, ICTs are dependable tools in facilitating the attainment of one of the Millennium Development Goals (MDGs), which is achievement of universal primary education (Mikre, 2011). Kofi Anan, the former United Nations Secretary General, points out that in order to attain the goal of Universal Primary Education; we must ensure that information and communication technologies (ICTs) unchain the door of education systems (Mikre, 2011). This indicates the growing claim and an increasingly important place that (ICTs) could receive in education. Since ICTs provides greater opportunity for students and teachers to adjust learning and teaching to individual needs, society is, forcing schools to give an appropriate response to this technical innovation (Mikre, 2011).

1.1.2 Persons with Visual Impairement

The use of the term 'people with disabilities' is understood in this research within the stipulations of the UN Convention on the Rights of Persons with Disabilities (2006) which states that: Persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hamper their full and successful participation in society on an equal basis with others (Kanter, 2006). In 2010, The World Health Organization (WHO) estimates that 10 percent of the worldwide population is disabled, which is about 650 million people. Some common causes of disability are diabetes, cardiovascular disease, injuries from road traffic crashes and conflicts, birth defects, malnutrition and HIV/AIDS (WHO, 2010). Among disabilities, visual impairment

(VI) is a significant health problem worldwide. Globally, about 314 million people are visually impaired, of whom 45 million are blind (WHO, 2010).

In the United Republic of Tanzania (URT) the occurrence of disability is estimated between 7.8 to 10 percent, which translates to 2.4 million people, based on the 2008 Tanzania Disability Survey (Mwakyusa, 2009 & CCBRT Strategy, 2008 – 2012). Mwakyusa went on to elaborate that vision impairment was the main source of activity restriction for the individuals who were surveyed, trailed by weakness of versatility and hearing (Mwakyusa, 2009). According to The National Policy on Disability URT, (2016) disability is the loss or limitation of opportunities to take part in the normal life of the community on an equal level with others due to temporary or permanent physical, mental or social barriers. Such a adversity or captivity could be aggravated by the community's impression of impaired individuals. Tanzania has the National Policy on Disability which aims to provide a conducive environment for people with disabilities to engage in productive work for their development and the utilization of available resources for improved service delivery (CCBRT Strategy, 2008 – 2012 & National Policy on Disability, 2004). Along these lines, educational organizations need to continue planning and conveying items and administrations that are usable by individuals with disabilities.

As in line with United Nations Resolution No. 27 (a)(iii) of 20 December 1948 which states that all human beings are born free with equal rights and dignity (UN, 2006). This resolution infers that all human beings are equal and hence have the privilege to the general public and its assets for their improvement and insurance.

1.1.3 ICT in Education and Disability

The ICT Opportunity for a Disability-Inclusive Development Framework ITU and G3ict, (2012) is a blueprint for sound development policies and programs to ensure the full participation of person with disabilities in all aspects of society. The agreements of the Convention must be implemented and the post 2015 development agenda should reflect its guidelines on accessibility to ensure the social and economic inclusion of this important group of the global population (Darrow, 2012). The framework stresses among other things, to remove ICT accessibility barriers faced by PwVI. In today's world, with the universal impact of ICTs across all sectors, no one should be excluded from using mobile phones, the Internet, televisions, computers, internet cafe and their myriad of applications and services including in education, political life, and cultural activities or for e-government or e-health to mention a few examples (ITU and G3ict, 2012).

The dispositions went ahead to expound that accessible ICTs have the ability to provide persons with disabilities unmatched levels of access to education, abilities to do business, and also the chance to take an interest in the financial, social and social existence of their communities. Considering that 15 percent of the world's population, one billion people, has a disability that affects their access to ICT, there is a significant need to improve the access to ICTs for persons with disabilities (ITU and G3ict, 2012).

1.1.4 ICT Access Barriers for PwVI

The act of integrating ICT into teaching and learning is a complex process and one

that may encounter a number of difficulties; these difficulties or challenges are known as “barriers” (Rhema, Amal & Iwona, 2009). Distinctive classifications have been utilized by analysts and researchers to characterize these barriers of ICT usage in education. One of the classifications found in the literature is teacher-level barriers versus school-level barriers (Bingimlas, 2009). Becta grouped the barriers, according to whether they relate to the individual (teacher-level barriers), such as lack of time, lack of confidence, and resistance to change, or to the institution (school-level barriers), such as lack of effective training in solving technical problems and lack of access to resources (Becta, 2004). Similarly, Balanskat divided them into micro level barriers, including those related to teachers’ attitudes and approach to ICT, and meso level barriers, including those related to the institutional context (Balanskat *et al*.,2006). The latter added a third category called macro level (system-level barriers), including those related to the wider educational framework (Bingimlas, 2009).

In spite of the incredible opportunities given by using ICTs for learners with disabilities, there are a many barriers/challenges that impede with their efficient use. A major concern is that departments and people responsible for deploying, supporting and executing ICTs within the university, in the hurry to incorporate ICTs into teaching and learning, fall short to take into account about the accessibility needs/challenges of people with various disabilities (Burgstahler, Corrigan & McCarter, 2005). For example, those in charge of supporting, implementing and deploying ICTs generally do not verify prior whether the newly purchased/developed software is compatible with adaptive software that reads what is on the screen.

Crowded web-based application with a lot of images and links can pose navigation or accessibility problems for students with learning and visual disabilities even when they use adaptive software such as screen readers.

Despite the availability of a growing number of technology-enhanced and sophisticated assistive technology devices, PwVI still faces a number of ICT accessibility problems (Seale, 2013). These barriers include poor availability and accessibility of information and communication technologies, as well as some specific forms of web-based software, which pose problems even when PwVI use adaptive software (Burgstahler, Corrigan & McCarter, 2005). Accessibility and usability problems can be found in the different categories of information system, including web based application, even if the computer have been kept in their standard configuration and other specific hardware devices are included. Information systems often pose a variety of accessibility problems to visually impaired Persons, including small characters, crowded pages, pop-up windows, iconic menus, complex forms to be filled in, screen navigation. Any software application with these kinds of problems will not be accessible or usable by PwVI. Hence, these ICT solutions will make PwVI unable to access some contents of the software application.

The increased use of Information and Communication Technologies (ICTs) in education sectors and recent developments in adaptive hardware and software has allowed people with disabilities to do things that were difficult or impossible for them to do in the past (Loots *et al*, 2015). For example, it has allowed people who are blind to read using text-to-speech technology, people who are deaf to

communicate using chat programs, and people with difficulties using their hands or arms to write and communicate using dictation software (Fichten *et al*, 2009). PowerPoint presentations in class, the use of web-based discussions to further in-class conversation, or courses delivered completely over the Internet are some of the use of ICT in education (Bain *et al*, 2010).

Performance of students with various disabilities can be increased tremendously using ICTs. For example, online academic programs provide enhanced opportunities for people who, because of climate, health, transportation or physical accessibility, experience barriers to attending classroom-based courses (Burgstahler, Corrigan & McCarter, 2005). Likewise, visual impaired students can access course study notes and handouts on the eLearning platform without the need of assistance, as long as these ICTs are designed to be accessible.

1.2 Statement of the Problem

With the use of ICT many students have faced challenges related to how best to use ICT. More challenges are related to the use of ICT for persons with disabilities, especially those with visual impairment (Seale, 2013). This causes problems for people with disabilities, especially visually disabled persons, to access ICT products and services provided as the interaction the people have with ICTs is mainly through their eyes (Hollier, 2007). Based on these ICT accessibility problems, at OUT PwVI were using recorded audio tapes. The university motto “affordable and Quality education for all” is not applicable for PwVI since they are unable to access ICT which enhances the delivery of education.

In Tanzania and in particular, most of the studies are based on digital divide caused by infrastructure, socioeconomic, demographic, and cultural dimensions, leaving aside impairments especially visual impairment (Newa, 2012). Newa went on to show that most of the business institutions in Tanzania are not considering PwVI when implementing ICT (Newa, 2012). To this extent, this study establishes ICT access barriers and their corresponding solutions at OUT. Existing solutions and their compatibilities were analysed and new solutions were designed and tested in the course of the study.

1.3 Objectives of the Study

The overall objective of this study is to propose solutions that, when applied in the software designing, will produce or improve ICT accessibilities for persons with visual impairment at Open University of Tanzania (OUT).

The specific objectives of this study are;

i) To identify forms of teaching and learning processes related to applications of information and communication technologies at OUT.

ii) To establish ICT-access needs of the PwVI at OUT.

iii) To establish suitable Solutions to the ICT access needs/problems faced by PwVI at OUT.

iv) To propose a software framework for developing accessible ICT for PwVI.

1.4 Research Questions

To reach the purpose of this study the following research questions are asked:

i) What are the forms of teaching and learning processes related to applications of information and communication technologies at OUT?

ii) What are the ICT-access needs for the visually impaired persons at OUT?

iii) What are the solutions that exist to the problems faced by PwVI in using ICT at OUT?

iv) How should institutions reduce ICT accessibility barriers to PwVI?

1.5 Relevance of the Research

The findings of this study contribute in the increased understanding of how to solve the problems of accessibility when using ICT considering PwVI. Information communication technologies have social, economic, environmental and political impact in the modern society (Islam, 2015). ICT has become a tool for social change and derivaring education content (Pelgrum & Law, 2003; Sharma, 2003; Sanyal, 2001; Bhattacharya and Sharma, 2007; Tedla, 2012; Tilya, 2007) and also for supporting persons with special needs and disabilities in education (UNESCO, 2006; Vicente & López, 2010). Gronlund et al. (2010) confirms that access to special materials for education of disabled students also appears to be insufficient. This in turn may affect the accessing and using of information also education performance of visually-impaired students.

To date, little is known on the extent to which one can make a possibility on making PwVI bea able to access and utilize ICT to support learning among visual-impaired students in Tanzania. Generally it is known that teachers of students with visual impairments are not prepared to use assistive technology and to teach students how

to use it (Smith & Kelley, 2007; Sismek, Altun, Ates, 2010) some reasons in using ICT may be because there are no specialized staff who would provide support and create ICT accessibility solutions for PwVI. This calls for developing ICT knowledge that enhances development of ICTs that are compatible to PwVI resulting in inclusion of PwVI in educational activities. Benefits of PwVI inclusion in education not only be beneficial to PwVI but also to the education institutions including Universities, and society at large. Furthermore, the findings of this study provide a road map in implementing policies that are expected at bringing parity and empowerment to the PwVI to participate in ICT educational process. This study provides opportunities for ICT training institute and department in the university to plan training programs for PwVI and include IT curriculum for designing accessible web-based applications and websites. Through better access to education, the PwVI are enabled to attain quality knowledge and hence contribute in socio-economic advancements and improve their quality of life.

1.6 Assumptions and Limitations of the Study

The assumptions for this study was that with increased use of ICT, creating platforms that are accessible to persons with visual impairment increases enrollment of persons with visual impairment at the Open University of Tanzania. This assumption assumed that OUT websites where teaching and learning is accessed by the OUT students was inaccessible for the PwVI. This study therefore sought to provide information on the levels and issues of Web accessibility compliance of the home pages of the Open University of Tanzania website, email server and Learning Management System (LMS) (MOODLE). Another assumption was that most of the

System Administrator and Developers were having difficulties in producing accessible home pages. The findings were assumed to be used by other institutions, including the Open University of Tanzania to analyse and improve web-based application accessibility to PwVI. It was also assumed that AChecker oline tool for software accessibility checking could be used to test web-site accessibility issues.

This study focused on accessibility issues for visually impaired persons at the Open University of Tanzania and only on issues related to access to the institution's home pages of website, email system and MOODLE accessible on use of computers only, as such mobile phone applications and other Assistive Technologies though can be used in learning were not part of this study.

1.7 Conceptual Framework of the Study

A conceptual framework is a pictorial narrative form of the main composition of the study. For the PwVI to fully access education using ICT, they would need some important components. For this study, a conceptual framework was design as seen in Figure 1.1.

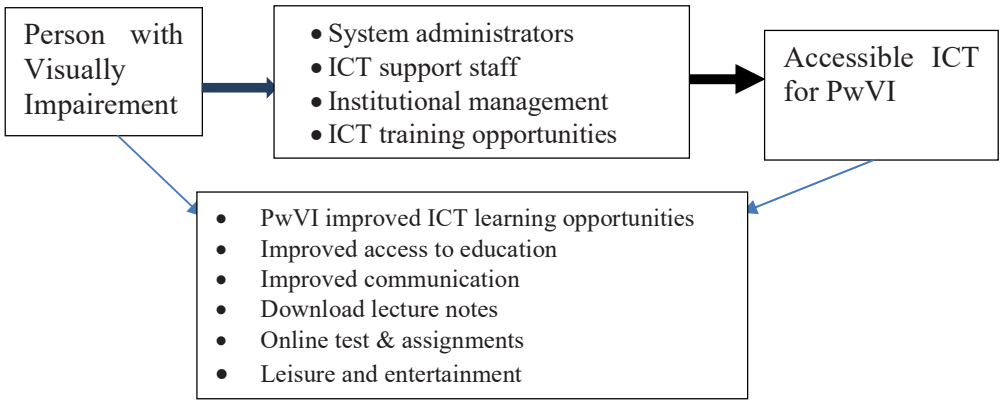

Figure 1.1: Model for Studying the Use of ICTs for PwVI

The framework considers persons with visual impairment as the primary; these are the ones who face challenges. It is thus important to hear from them. As described earlier, it was the visually impaired staff that identified the accessibility problem. He could not solve it thus involved management, IT administrator and as a support staff. In this case system administrators/developers, Institutional management, support staff, and ICT training opportunities to acts as a bridge for ICT access to the PwVI. There is a question of why they need access to ICT. Generally, in education institutions like the Open University of Tanzania, the needs of the PwVI are synonymous to those of other students. These needs include PwVI improved ICT learning opportunities: Improved access to education and learning content in particular, improved communication; download lecture notes; leisure and entertainment and ability to participate in Online test & assignments.

1.8 Organization of the Study

The study is structured into six chapters. The first chapter introduces the background to the problem and the overall chapter arrangement. Chapter two consists of the review of related literature on the current research topic. Chapter three is research methodology for data collection and analysis procedures. Chapter four, deals with presentation, analysis and discussion of the findings. Chapter five presents the frameworks of the study. Chapter six gives the summary, conclusion and recommendations of the study.

CHAPTER TWO

2.0 LITERATURE REVIEW

This chapter presents a literature review on issues related to ICT solutions to web-application accessibility, especially on issues pertaining to PwVI. It will also explain concepts related to the use of ICT by PwVI and Assistive Technologies (AT), supporting theories, shows the empirical analysis, conceptual analysis and the underlying theories. Lastly this chapter will analyse pertinent system administrator/developer skills in understanding web accessibility and how their education and experience can affect their Web application design.

2.1 Benefits of ICT in Education

The adoption and use of ICTs in education have a positive impact on teaching, learning, and research (Noor-UL-Amin, 2013). Noor-UL-Amin went on to elaborate that ICT can affect the delivery of education and enable wider access to the same. In addition, it will increase flexibility so that learners can access the education regardless of time and geographical barriers. It can influence the manner in which students are taught and how they learn. It would provide the rich atmosphere and motivation for teaching and learning process which seems to have an insightful impact on the process of learning in education by offering new possibilities for learners and teachers. These positive possibilities will have an impact on student performance and accomplishment. Similarly the wider availability of best practices and best course material in education, which can be shared by means of ICT, can foster better teaching and improved academic achievement of students (Eschenmann,

2012). This suggests that ICT was successfully integrated into education. However, with the shift from direct physical interaction to web-based interfaces, it gets more difficult for people with visual impairments to perform everyday's tasks on the Internet, such as online transaction processing and looking for information (Bergman & Nygren, 2009).

2.2 Human – Computer Interaction (HCI)

To access the ICT, the person needs to interact with computers, this interaction is called Human-Computer Interaction (HCI). The goal of Human-computer interaction is to produce usable and accessible systems, as well as functional systems. The link between users and computers is often done at the HCI, often just called the interface (Newa, 2012). The interface includes both software and hardware, such as general-purpose computers and large-scale mechanical systems, such as aircraft and power plants (Noor-UL-Amin, 2013).

Designing products which are interactive and that can be easily used, requires that one to consider who is going to be using them and where they are going to be used. A major reason for having a better understanding of users is that different users have different needs and interactive products need to be designed accordingly (Bergman & Nygren, 2009). To meet the criteria of interactive design, Jacko states that usability and user experience goals should be met. Usability goals: Usability is generally regarded as ensuring that interactive products are easy to learn, effective to use, and enjoyable from the user's perspective (Jacko, 2012). It involves optimizing the interactions people have with interactive products to enable them to carry out their

activities at work, school, and in their everyday life. While in User experience goals: Interaction design is increasingly concerning itself with creating systems that are improving efficiency and productivity at work. They should offer increased opportunities for supporting people in their everyday lives.

Jacko writes that vision, hearing and touch play important roles in Human-Computer Interaction (Jacko, 2012). The PwVI must make use of their hearing and touch to interact with their environment. For people with severe visual disability hearing is the most important way to interact with computers. For people without disabilities, vision is the most important way of interacting with computers, followed by hearing and touch.

2.3 Visual Impairment

Impairment is an attribute and condition of an individual's body or mind which, unsupported, has limited, does limit or will limit that individual's personal or social functions in comparison with someone who has not got that characteristic or condition (CCBRT, 2008). Impairment is largely an individual issue and it relates to a physical, intellectual, mental or sensory condition. One of the major type of Impairment is Visual impairment (VI). Different scholars have defined visual impairment differently, some include blindness and others exclude blindness on their definitions.

Some of the definitions are; Visual impairment is the term used for people who have some degree of sight, but who have, for example, a limited range of sight and focus

that cannot be easily corrected with spectacles, who are squint, who need special lighting to be able to see, who have blurred vision or who have tunnel vision (Bell, 2013).

Also, (Newa, 2012) on their description of persons with vision impairments included terms such as partially sighted, low vision, legally blind, and totally blind are used in the persons with visual impairments. These terms are elaborated further as follows; partially sighted indicates the kind of VI problem that has resulted in a need for special education; Low vision: is the kind of VI problem which the loss cannot be corrected by ordinary glasses, contact lenses, medication or surgery (Newa, 2012). Lawfully blind indicates that a person has a very limited field of vision; and totally blind person, who has no vision at all and depends on other non-visual media. In this study, people with visual impairment are considered to involve both with limited visibility and complete blind persons (CCBRT, 2008).

2.4 The ICT and Persons with Visually Impairement

In many studies it has been demonstrated that ICT is not only reducing barriers of access to information, but at the same time creating barriers (Mnyanyi & Mbwette, 2009; Newa, 2012). People with visual disabilities face special barriers in using the ICT (Puffelen, 2009). This is due to the need to interact with computers which are also not customized for people with visual impairments since they present most of the interaction and information visually to the user (Bergman & Nygren, 2009). Therefore, the interface, and the main output devices like computer monitor must balance for this discrepancy. The interface design will be of significant importance if

the person using the computer has some kind of visual impairment (Bergman & Nygren, 2009). There are a lot of different aiding devices known as assistive technology (AT) that enables PwVI to use computers.

ICT offers an assortment of specific hardware and software solution for conveying, getting to and inputting information/data to/from web-based applications. Following are some of the ICT tools/applications for assisting different kind of disabled learners to perform functions within abilities. These includes

i) Specialized Keyboards
ii) Braille
iii) Braille Printer
iv) Screen Readers
v) Talking word processors
vi) Screen Magnifiers.

Screen magnifier application: This is the gadget that enlarges a little territory of the presentation, filling the whole PC screen. The person using a computer can move the spot being amplified on the desktop. This allows the user to control the computer interface, and is a good solution for people with gradually-degrading vision, especially those who are already familiar with their computer interface, but are starting to have trouble seeing it, but it has no assistance to completely blind (Newa ., 2012).

Text Browsers: To shun problems of using the mouse and hypermedia, most visually impaired persons use text-based Web browsers (Lynx) that will disregard graphics on

Web pages and allows the use of the keyboard to activate hyperlinks (Newa, 2012). However, since many Web designers only check their designs on popular browsers such as Netscape and Microsoft Explorer, they often use features that are not supported by text browsers; blind users often have problems accessing such web sites (King *et al*., 2005). Internet surfing problems for the completely blind people cannot be solved completely by using Text browsers.

Screen Readers: This is a technology which uses speech synthesis and was invented since the late 1970s. This technology enables the blind to access most text-based computer displays output using speech generated by screen readers. In any case, the technology only perusing the content of the screen and changing over it to human speech (Norman., 2013). The screen reader tends to read the screen content in blocks of words and in sequential manner which web-based application navigation like internet surfing requires real time reading of the screen therefore in some cases not perfect for web-browsing.

In addition, the fact that the screen reader always "reading aloud" every item on a Web page and consequently asking the user to make succeeding correct choices will definitely constitute a heavy burden on a humans' short term memory which will render it a poor HCI technique (Newa, 2012). In order to activate the next Web page, the user still needs to point to a specific hypertext link and click the mouse, an action which is nearly impossible for a visually impaired person, hence innovative methods must be developed if visually impaired people are to have natural access to the Internet (chungurski *et al*, 2012).

Braille Printout and Braille Devices: The output of any computer system can be predominantly passed on to people through paper printout. As blind computer users cannot read ordinary paper, they had to read computer output by touching paper specially indented with a pattern of raising dots called "Braille" (W3C, 2011).

Braille Device: A Braille device is another alternate output device for the blind. A small part of the image of a computer screen can be generated on the device; a visually impaired person can read it quickly by touching the device and does not have to wait for the generation of the Braille paper (chungurski *et al*, 2012). These devices are very expensive where a typical one device costs about six times as a computer. People with disabilities normally have far lower incomes than other citizens (National Council on Disabilities, 2001).

2.4.1 Accessibility and World Wide Web Consortium (W3C) Framework

Accessibility is the feature of a system that makes it effortless to learn, easy to use, easy to remember, error tolerant, and subjectively pleasing (W3C, 2011). Content and tools included in the ICT should also be accessible. The people with disabilities should be able to use and access all the information provided for the learning experience, regardless of the type or degree of disability they suffer (Nielsen, 2010). Web Accessibility Initiative (WAI) guidelines are the result of the conference that the World Wide Web Consortium (W3C) adopted for promoting the use of ICT for people with disabilities (W3C, 2011).

Web Content Accessibility Guidelines (WCAG 2.0) has set a wide range of recommendations for making ICT content more accessible to a wider range of people

with disabilities (W3C, 2011). These disabilities include blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited movement, speech disabilities, photosensitivity and combinations of these will make web applications developed using these guidelines make Web content more accessible to users in general (W3C, 2011). WCAG 2.0 gives guidelines to help system developers to design accessible ICT. The guidelines cannot be tested, but they provide the important framework to help developers understand the success criteria and better implementation of the accessibility standards.

The guidelines of the framework are:-

i) Provide text alternatives for any non-text content.

ii) Provide alternatives for time-based media.

iii) Create content that can be presented in different ways without losing information or structure, make it easier for users to see and hear.

iv) Make all functionality available from a keyboard.

v) Provide users enough time to read and use content.

vi) Do not design content in a way that is known to cause seizures.

vii) Provide ways to help users navigate, find content, and determine where they are.

viii) Make text content readable and understandable.

ix) Help users avoid and correct mistakes.

x) Maximize compatibility with current and future user agents, including assistive technologies (W3C, 2011).

User Agent Accessibility Guidelines (UAAG) 2.0 for software developers explains how to make accessible browsers, multimedia players, and assistive technologies that interface with these (W3C, 2011). AChecker is one of many tools for testing web-based application accessibility. This is one of many online automatic verification tools that can check for WCAG 2.0 accessibility compliance and other usability measures of websites which was created by the University of Toronto (W3C, 2011).

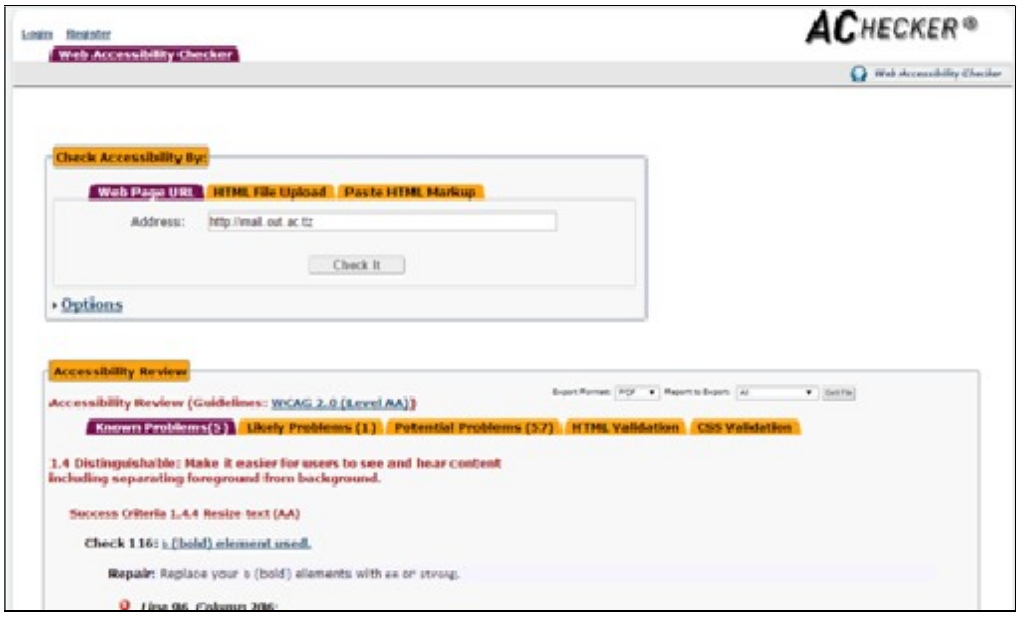

Figure 2.1: ACheaker Validation Output for Mail Server of OUT

2.5 Problems faced by PwVI in Using ICT

Visual impairment is the major disability type that usually causes most serious accessibility issues (Newa, 2012). When determining how disability affects accessibility, blind people are considered to be unable to access a web page, if they are not provided with assistance in the form of a screen reader or an audible web client (Yuan *et al*, 2011). Despite the fact that these assistive technologies are valuable, their application in solving the accessibility issue is to some degree

restricted. The excessive use of graphics without necessary guides or aids results in a web page being categorically unreadable. This shows that most of the web application and websites are designed to be visual; hence nearly all PwVI are then automatically excluded.

According to W3C, PwVI will encounter a number of problems in using ICT and websites (W3C, 2011). These problems include: Images that do not have alternative text; Complex images (graphs or charts) that are not adequately described; Video that is not described in text or audio; Tables that do not make sense when read serially (in a cell-by-cell or linear fashion); Frames that do not have NOFRAME alternatives or that do not have meaningful names; Forms that cannot be tabbed through in a logical sequence or that are poorly labeled; Browsers and authoring tools that lack keyboard support for all commands; Browsers and authoring tools that do not use standard applications programmer interfaces for the operating system they are based in; Non-standard document formats that may be difficult for their screen reader to interpret (W3C, 2011).

Although PwVI may seem to experience greater difficulty than those who are partially sighted, but the fact is that they all experience some kind of problems, this is as the result of lack of consistency in web design along with the highly visual nature of most ICT (Good, 2008).

2.5.1 Needs of PwVI in Using ICT

Regardless of all the progress in the designing and development in the field of assistive technologies, the growth in technological development and use of ICT in

teaching and learning, for assisting disabled still suffers from limitations(W3C, 2011).Kuppers mentioned the needs of PwVI in using ICT as

i) Lack of specialized disabled friendly teacher training;
ii) Limited flexibility in training options for people with disability;
iii) Limited availability of specialized disabled friendly hardware and software resources, due to business constrains;
iv) Lack of formal involvement of the government organizations and support structure for ICT for the disabled;
v) Attitude barriers towards people with disability;
vi) Lack of appropriate disabled friendly policies and their implementation
vii) Limitation of finances as most of the ICT tools compatible for PwVI are very expensive (Kuppers, 2013).

Below are some recommendations by Kuppers which, if taken care of, while suggesting, planning, using, developing tools, applications and infrastructure for people with disabilities, will have great impact on teaching and learning (Kuppers, 2013). Those solutions are

i) Improvement of networking facilities to allow more effective co-operation between institutions and tele-centers to assist all types of disabled people using online network;
ii) Adaptation of standard software to the needs of learners with visual impairment;
iii) Creation of virtual environment for supporting different types of disabled learners;

iv) Customization of workspace setup to fit a wheelchair;

v) Development of user-friendly multiple types of user interfaces for the same devise application for facilitating different types of disables , to increase their ability to use the services;

vi) Making of people with disabilities as part of the decision making and planning effort alongside disability experts in projects related to disabled users;

vii) Making tools used by disabled, to create, check and validate educational content, in such a way so that it should be accessible for teachers and system administrators with disabilities;

viii) Providing consistency in the layout of keypads at least for blind learners;

ix) Enabling hearing impaired person with access to audio output with proper volume control;

x) Advocating and supporting of more open source applications development for people with disabilities and the application of user agent accessibility guideline by W3C.

2.5.2 Organizational Administration and Policies

The Web accessibility literature often acknowledged the call for organizational policy, administration, and leadership to address the need for accessible ICT. (Cardinali & Gordon, 2002) stated that web products should have policy launch early in the development and process stage. (Milne *et al*., 2005) recommended that ICT accessibility policy needs to be carried out through the administrative, managerial, and developer roles. (Byerley & Chambers, 2003) stated that there is also a need to

create a Web accessibility policy statement to provide guidance on every information system development. It is a feasible process to ensure that system administrators are able to follow created organizational policy and guidelines and be provided educational opportunities to improve their information system development skills (Hudson, 2002).

When an agency has many system developers and policy and decision-makers involved, more issues arise in ICT accessibility compliance (King *et al*., 2005). Be it Web accessibility or other information technology issues, studies indicate that well implemented policies for the top level administration throughout the organization can greatly assist an information technology project. ICT accessibility policies can set the stage for specific processes and activities to reformatting the organizational ICT application to be more inclusive. For a public agency, the first step to create ICT accessibility policy is to ensure all system administrators understand accessibility issues regarding their programming and design skills (Amtmann, Johnson, & Cook, 2002). The organization can adopt the widely utilized standards of WCAG (W3C, 2010) guidelines.

2.5.3 System Administrator's Skills

With proper understanding of ICT accessibility, legal requirements, and how to design and program for accessibility, a system administrator has a much higher probability to produce an accessible ICT application (Byerley & Chambers, 2003). An understanding on how to correct these issues was needed where the system

administrator's accessibility knowledge was essential in effectively solving these ICT accessibility problems (Bevan & Ahmed, 2007).

To discover the solution of various types of users with disabilities, an understanding of those users with visual impairment (ranging from low vision to blindness) and hearing, mobility, and cognitive impairments, as well as those suffering from seizure disorders are important (Hudson, 2002). There are other alternative methods use for testing ICT accessibility if disable individual cannot be found. (Smith, 2009) utilized simulations of users with disabilities for testing the ICT application.

It is very imperative for ICT application accessibility to be checked by system administrator during and after system development. System Administrator/developer can view ICT application accessibility on a monochrome or high contrast screen while turn off graphics; use the keyboard with no mouse; and print out the pages in text only and read to ensure simplistic and understandable language (Flowers *et al*., 2000). A System developer could also be helped by utilizing a text browser, such as Lynx, that analyses image, navigation, and frames issues as well as other accessibility problems (Seale, 2013).

To this extent the literature reveals that it is important for a system administrator/developer to equip themselves with ICT accessibility guidelines (WCAG), web-application accessibility tools, incorporating ICT users with disabilities or heuristics, understanding the proper use of HTML, and/or using a variety of other navigation/browser options (W3C, 2010). Learning about ICT

accessibility as well as the problems relating to it is good for web development education, as this will bring a trend towards designing for the user, rather than for other reasons, such as aesthetics, politics, meeting deadlines, and so forth (Eschenmann, 2012).

2.6 The Need of ICT Accessibility Framework for PwVI

In light of the vital role ICT plays in modern-day university society, including in the viewing of examination results context, the human-right aspect, getting information through email systems and download study materials through a learning management system, it is very important to have a framework that will be used by the university to develop or acquire accessible ICTs. Various studies as shown below indicated that one aspect to achieve this is the need of having development processes that will produce accessible ICTs for PwVI. On a micro level, ICTs themselves, particularly mark-up languages and their underlying interpretation or execution models, must be made more accessible to developers and maintainers as well as users (Jacko, 2012).

Khwaldeh proposed a centralized based learning system, which aims to facilitate teaching and learning for both teachers of the deaf and deaf people (Khwaldeh, *et al*, 2008). Through this system, instructors and students who are both deaf can communicate with each other. But this framework is for the deaf only. Kyun proposed an E-Learning framework that creates a common platform for both normal and disabled students which will share the same influences of their academic achievement (Kyun Ng *et al*,2008). The students can message each other in a chartroom. But the system developed in this framework is very complex and

therefore needs a lot of training. Many institutions that adopted accessible ICT are doing so in the basis of the concept of “universal design”. Universal design is the means by which product and services that are acquired by the institution by means of designing, purchasing and leasing only if they can also be used by people with different disabilities.

2.7 Theoretical Perspectives on the Study

2.7.1 Technology Acceptance Model (TAM)

The model asserts that the intention to use ICT is determined by two generalized beliefs; perceived usefulness (PU) and perceived ease of use (PEOU) are the essential significance for the ICT acknowledgment conduct (Jaeger, 2006). These two beliefs will be used to predict the use of ICT by PwVI.

In this study the use of ICT by PwVI is determined by the acceptability of ICT applications among PwVI, availability of services provided through the ICT, accessibility of the ICT application to PwVI and policies/regulations determining the use of ICT application by PwVI. Acceptability of ICT application technology among PwVI encompassed the user’s perceived usefulness and benefit of a technology as a means to understand whether or not the user accepts or rejects the technology. For example the accessibility of a website also influences the PwVI use of the Internet (W3C2, 2010). Specific Web technologies could bar users from using the ICT all together (Kyun Ng *et al*,2008). A PwVI user perceives the ICT application as useful in the case of working with their assistive technologies. The organization’s perceived benefit of and ease of use of implementing policies and regulations regarding ICT

accessibilities on organizational policies and practices. But more importantly the diverse group of stakeholders and the views and perceptions they hold about disability are enough to understand the complex situation of developing an accessible ICT application (Jaeger, 2006).

Table 2.1: Criteria Used to Understand TAM from PwVI Perspective

TAM	Objectives
Perceived Usefulness	Teaching and learning processes related to applications of information and communication technologies at OUT
Perceived Easiness	Special ICT-access needs of the PwVI and determine whether these are fulfilled by the university
	The establishment of Solutions to the problems faced by PwVI in using ICT at OUT

2.7.2 The Study Variables

The relationship between variables of this study are indicated in the figure below

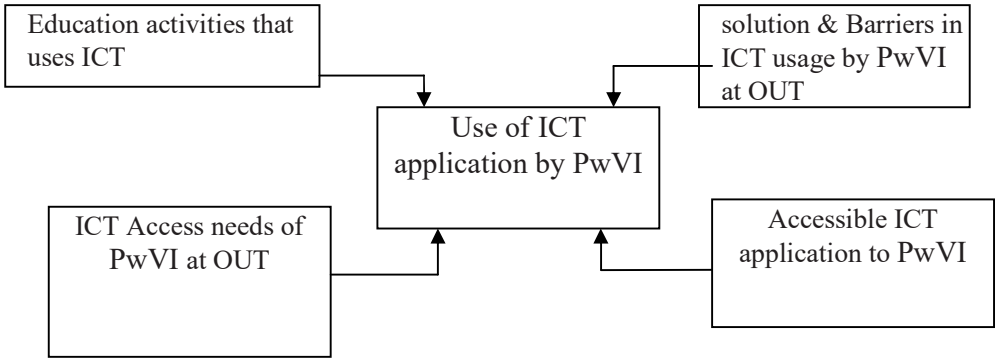

Figure 2.2: Relationship Between Study Variables

2.8 Empirical Literature Review

This section attempts to relate this study with research works done by others in the same area. A study by Petty (2005) aimed at providing an overview of barriers and solutions to virtual access solutions for persons with visual impairments to workplace

technology. Data were collected from interviews and surveys. Empirical findings of this study created a compelling argument for improved access by showing how the barriers to virtual work frustrated and hampered PwVI workers. This study indicated a need to increased use of ICTs at workplaces as the future workers' primary activities wrer expected to involve information technology. These facts make it imperative that visually impaired have an effective level and quality of access to ICT that is essential for full participation in new ways of working and learning. PwVI are likely to benefit from assistive technology software and hardware such as screen reading software, Braille and screen magnification (Petty, 2005; Mnyanyi, Bakari & Mbwette, 2010). In concluding the author commented that, leaders can develop competencies to incorporate workers with VIs into the workforce at ease. A petty's study was conducted in America a first world country, this study will be conducted in Tanzania, a third world country, where the issue of ICT for PwVI is not common.

Bergman and Nygren (2009) conducted a study with the purpose of finding out how websites should be made accessible and designed so that they function as well as possible with the aiding devices of the visually impaired. This study used qualitative methods in a deductive approach. This study found that; there are factors that can make it difficult for the visually impaired to access websites, as well as websites can be made as accessible as possible for the visually impaired persons by following the standards of HTML and the guidelines for accessibility developed by the World Wide Web Consortium, to create websites that are accessible and user friendly for all users in general, and especially for the visually impaired and their aiding devices (Bergman & Nygren, 2009).

Fuchs & Horak (2008) conducted a study with the aim of discussing the digital divide in Africa and possible solutions. One of the findings of this study indicated that the costs of Internet use in African countries are extremely high as compared to Europe and USA. Another finding indicated that structural inequality in modern society is the reason why there are gaps in access, usage/skills, benefit, and participation concerning ICTs, causing different types of the digital divide such as the global divide, the gender divide, the ethical divide, the age divide, the income divide, the educational divide, and the abilities divide (Fuchs & Horak, 2008). People with high income, far-reaching and influential social relationships, good education and high skills are much more likely to have access to ICTs, to be capable of using ICTs, to benefit from this usage, and to be supported in political participation by ICTs than people who are endowed with only a little amount of economic, political, or cultural capital (Fuchs & Horak, 2008). Further, they said that reducing to the digital divide to a technical problem and argue that material access possibilities and the opening of markets will result in a closing of the gap. Also, an alternative network society that is based on alternative principles of production, distribution, and regulation is needed.

Ndume, Tilya and Twaakyondo (2008) conducted a study on challenges of adaptive e-learning in higher education in Tanzania. One of the findings of this research is that, it was discovered that the plan of eLearning tools must ensure reliability, accessibility and sustainability of the program (Ndume, Tilya and Twaakyondo, 2008). Instruments intended for eLearning should likewise make space for development and must be modest for a training administration. Prior to launching

eLearning, management needs to ensure that there are enough assets needed by learners and that they are accessible anywhere and at any time.

Newa (2012) conducted a study to assess the use of ICT in business processes by PwVI in Tanzania. The study shows that many business organizations did not consider PwVI when implementing ICT for their services. The reasons being that the implementation of those ICT technologies to support PwVI is very costly, PwVI have less contributions in their business, scarce of the technology and the inability of PwVI in using those technologies (Newa, 2012).

2.9 Knowledge Gap

International agreements, Laws and ethics require all human beings to be included equally in every social-activity including access to education and in the learning processes in an institution. Institutions are massively adopting ICTs in their learning processes. Persons with visual impairment have a right to access education in different learning environments including use of ICT. Use of ICT in the learning process for visually impaired persons is hindered by their inability in most cases to access learning facilities and accessible ICT infrastructure suitable for them. At OUT there are students who are visually impaired started being enrolled in 1997 and do learn through use of Audio-cassette. The question is how do they benefit in learning in the era of use of ICT? For PwVI to use ICTs effectively and efficiently they need special considerations. Thus, institutions using ICTs in their teaching and learning processes are required to include those ICTs which will not deny PwVI access to their ICT infrastructure and hence services.

From the empirical literature review, it shows that not much has been done in the area of practical ICT accessibility solutions for PwVI. Therefore the knowledge gap between the inaccessibility of ICT at OUT by PwVI and the practical workable solutions provided to solve the problem is a fundamental challenge this study is aimed to address. Moreover expections, perception and targets are that OUT, should focus on increasing accessibility of its ICTs by providing ICT accessibility needs for PwVI and increase ICT access awareness for PwVI.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

In this chapter we will give details about how the research was conducted. The chapter research design, data and sources, methods of data collection and analysis, as well as population and sample size The fieldwork of this study was conducted from August 2015 to December 2015 and a steady correspondence has been maintained with key informants from the study sites through face-to-face, email messages and phone calls. This research falls under the framework of both quantitative and qualitative research approaches. We resorted to using these approaches since they fit well with for a research like ours seeking information about a phenomena that affects life of respondents in the aspects of ICT accessibility challenges faced by PwVI.

3.2 Population and Sample

The study was carried out at 4 centers (Kinondoni, Mwanza, Mbeya and Tanga) of the the Open University of Tanzania (OUT) focusing on individuals with visual impairment who participated in ICT skills training between 2011 to 2015. The Open University of Tanzania started offering ICT skills training to visually impaired persons in 2011. According to the data from the office supporting students with disabilities, Assistive Special Technologies Unit (ASTU), a total of 212 students have participated in the ICT skills training short courses. This study had a sample of 50 respondents. Respondents included 36 sighted and 14 persons with visual impairment who participated in the skills training programme. Of the 36 sighted

persons, 8 were system administrators, 8 ICT instructors, 10 Management officials and 10 were students pursuing a BSc (ICT) at OUT.

OUT was chosen as the case study because of two main reasons. First, it is ahead in the use of technology to facilitate teaching and learning and therefore provides ICT soft skills to disabled and non-disabled persons to enable them access various technologies used by the institution. Secondly, ICT soft skills course for PwVI was conducted between 2011 and 2015; therefore, this makes it imperative to measure the impact it has had to students. Thirdly, as an employee of OUT, it is easier to get support from the chosen population and sample.

The ICT personnel respondents were selected based on the fact that they are directly involved in creating an ICT skills training environment for persons with visual impairment. In that a purposive random sampling and snowballing were applied (Creswell, 2013). It was purposive in the sense that only those involved in ICT accessibility were targeted. It was random in nature as all persons involved ICT accessibility had equal chance in the study. The snowballing was also used as respondents had a chance for recruiting other respondents. For ensuring variability, reliability and validity respondents were from different regions of Tanzania including Kinondoni, Mwanza, Mbeya and Tanga.

For the purpose of our study, System Administrators/Developers (SA) are the software engineers who participate in software development project, either in the systems designed from scratch or the one customized from free Internet sources. Other categories of the respondents are ICT tutors, ICT students and OUT

Management. These groups were responsible to identify if the university had awareness of ICT accessibility challenges for PwVI and whether the issue is addressed in the university policies. The management category involved senior level employees in the organization have the final authority to decide whether a new technology will be adopted by the organization or not. The tutors/ICT facilitators are the ones who teach ICT were also involved with a view to identify their ability to facilitate ICT soft skills training to persons with disabilities.

3.3 The Study Approach

The study first started by understanding the extent of the accessibility problems encountered by PwVI. This was done by going through the literature as shown in Chapter 2. The literature review together with researcher's personal experience at the study area, revealed the research gaps. The research gap involved factors that affect ICT accessibility by PwVI and therefore form the basis for the study's variables, research problem and objective. In order to understand the problems and their solutions in this study and study area other research tools were used including interviews, observation and documentary review. Both open-ended and close-ended questionnaire were employed to complement information which might have been missed from the previous tools. ACheaker was also used to test the degree of ICT accessibility and the ICT accessibility problem and then propose a general solution. In the absence of a PwVI, accessibility testing was done using the screen reader. Whenever there is a problem and no solution given from the study field, design and implementation of the solution (see Chapter 4) was done by using the guideline provided by W3C accessibility framework.

An average of approximately 40 minute interview session was conducted for each interviewer followed by mobile phone and email conversations. More conversations were between PwVI and SA as the two groups are highly involved in identifying ICT accessibility problems, proposing and testing different solution strategies.

The information provided from the interview was validated through simulation and testing. That is, a non PwVI can close his/her eyes and then use screen reader to confirm if what has been reported by the PwVI is correct. Other means of validating the data provided by PwVI and others was by using ACheaker, a software for testing ICT accessibility for PwVI.

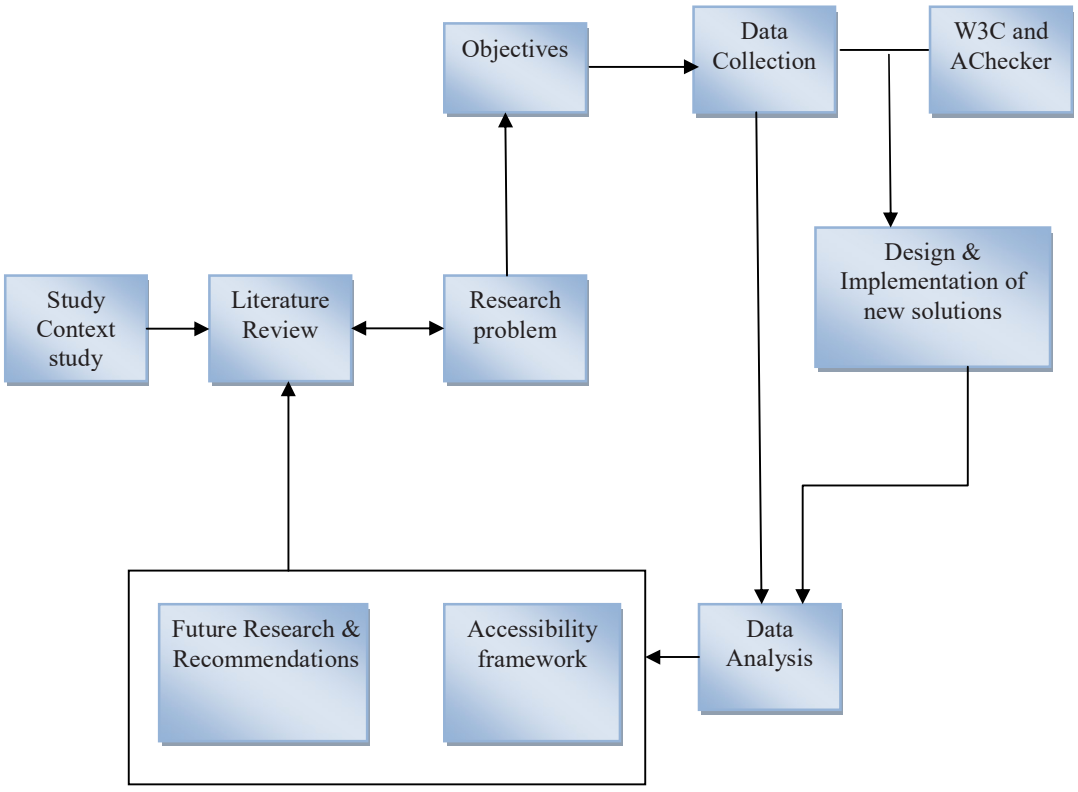

Figure 3.1: The Research Design

The study proposed two frameworks, one at institutional level and the other at technical level in acquiring or designing accessible ICT. Finally the study came up with a website which is more accessible by PwVI. Figure 3.1 above shows a general approach in which the study was conducted.

3.3.1 The Questionnaire

Appendix A, B, C, D and E represents the questionnaires used in our research. The non-PwVI respondents were supposed to fill the questionnaire under the supervision of the researcher while for PwVI the questionnaires were read to the respondents. This study involved open and closed ended questionnaires. The questionnaire comprised of set of questions for PwVI, System Administrators/Developers, OUT managers, ICT instructors and ICT students. The set of questions geared to understand ICT accessibility challenges and ICT accessibility solutions for persons with visual impairment.

3.3.2 Observation

The researcher made observation to OUT students and staff during their teaching and learning process. Teaching ICT skills for persons with visual impairment is done at OUT Headquaters where the reseacher also work. In understanding use of emails for persons with disabilities, the reseacher managed to make observation to one visually impaired person who also is an OUT employee and do use the same email system the reseacher use. The researcher being database management officer at OUT had a chance to observe and support visually impaired staff and students during ICT skills training sessions. The researcher gave explanations in brief for the respondents

about the nature of the study and the importance of the study. Also, researcher assures respondents, their confidentiality, anonymity on any information they provided.

The researcher supported installing Non-Visual Desktop Application (NVDA) and configuration so that it can support OUT systems including, mail system, for Visually Impaired students and staff to use. Both students and staff had instruction to send to the reaseacher email and read a document online This method enables the researcher to have a chance to see the problems encountered by PwVI when accessing ICT services. Moreover, it also enabled the researcher to have accurate information about the problems faced and the possible solutions which could not have been obtained through other methods like questionnaire and interview because of the respondents' lack of knowledge on the answers or not being co-operatives in the study (Marlow & Boone, 2005).

3.3.3 Documentary Review

In this study, the researcher uses documentary review to know the system administrator/developer qualification in dealing with ICT accessibility issue in web-application development and also to find if there is any official document that stresses the inclusion of ICT accessibility by PwVI. The documents that were reviewed included research papers, thesis, OUT master plan, Assistive Special Technologies (ASTU) reports, ICT policies, ICT evaluation reports, ICT curricula of different BSc (ICT) for two Universities and Carriculum Vitae of System Administrators/Developers.

3.4 Data Analysis

Data sets were classified according to attributes and variables. Those classes of data were coded and then given meaningful descriptions. Using Microsoft excel, the coded data were arranged into rows and columns and analyzed using tables and graphs. To ensure anonymity, only aggregate data is presented in this thesis. Any specialized, confidential reports provided remains confidential with the researcher. The data was de-identified after data was collected and coded for excel analyses and that this thesis is not using real names of respondents.

3.5 Reliability and Validity

To ensures validity, this study used a number of measures: (i) focusing on staffs who deal daily with ICT services in organizations to reduce the possibility that the results may be provided by someone who is unaware of the services provided, (ii) having more than one such staff in the ICT implementation participating in the interview answering the same questions and in the same order, the purpose being to countercheck whether different respondents give same account of the matters being investigated, (iii) focusing on visually impaired persons who have the knowledge of ICT and AT, (iv) the researcher did a pilot study and procedural validation to few respondent at OUT headquarter and modifying the instruments in order to ensure the data collected was valid and reliable, (v) multiple data collection techniques were employed which allowed the researcher to combine the strength and correct some weaknesses of one source of data. Thus, triangulation was employed.

To ensure reliability of the findings this study had taken the following measures: (1)

by having an interviewer-administered questionnaire to guide the interview rather than the “drop and collect later” approach. This strategy ensured that respondents answered the same questions and in the same order to control by the researcher where any misunderstanding of the questions were detected were rectified during the interview process. (ii) The researcher did a comprehensive literature review to obtain an understanding of the topic. (iii) Before distributing out the questionnaire to the respondents, the researcher did a pilot study and reorganized questions after the pilot study to make sure that the questions in a questionnaire were clear.

CHAPTER FOUR

4.0 DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter presents the results of the study and the analysis of those results. Therefore, this chapter present data obtained by observation, interview and questionnaire approaches as detailed in Chapter 3 with the respondents regarding their opinion and suggestion about their ICT access needs barriers and their related solutions. The learning and teaching activities that require ICT at the OUT, the needs of PwVI in accessing ICT and whether they are adequately met at OUT and finally assess solution that exists and suitability to the ICT needs of the ICT deployed at OUT.

4.2 Respondents Profile

To conduct this study, a total of 50 questionnaires were supplied to respondents who are visually impaired, who deals with visual impaired, and the management from four regional centers (Kinondoni, Mbeya, Tanga, and Mwanza) at the Open University of Tanzania .The respondent's category was distributed as follows: 14 (33.3%) respondents were students and staffs who are totally blind, 8 (19.05%) respondents were system administrator/developer (SA) and 10 (23.8%) respondents were ICT students, 8 (19.05%) respondents were ICT instructors, 10 (23.8%) respondents were staff management. These findings are represented by Figure 4.

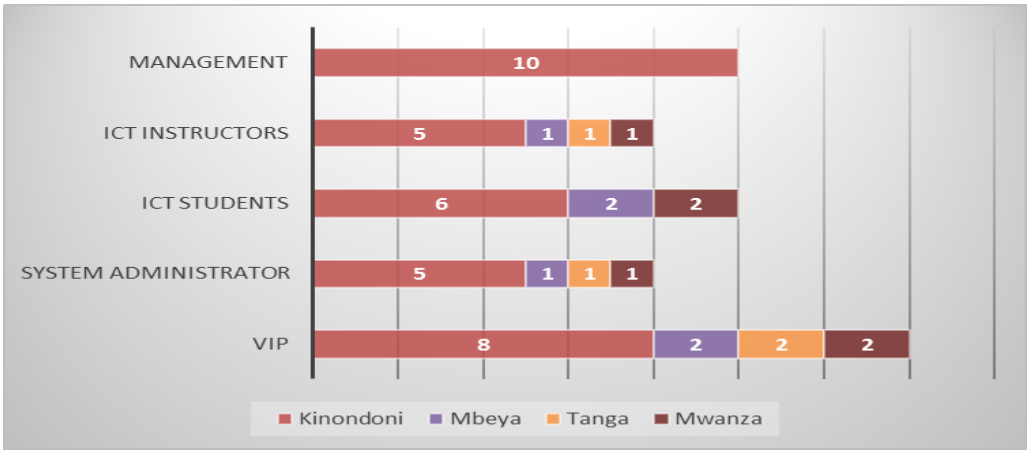

Figure 4.1: Distribution of Respondent by Category

4.2.1 PwVI ICT Literacy

The ICT literacy is very essential for visually-impaired students to access educational resources and programs such as those delivered via the Internet or multimedia educational portals. The PwVI were asked to indicate their computer literacy and the responses were summarized. The analysis shows that 13 (92.9 %) of the students and staffs who are PwVI were computer literate, this is because OUT has a special unit responsible for providing computer training for PwVI.

4.3 Teaching and Learning Activities Driven by ICT

Then the researcher asked if there were any learning or teaching activity that uses ICT at the University. This question is very important for the following two reasons. (1) To make sure that the selected case study is the right place to carry the study. (2) To establish the learning and teaching activities that use ICT at the University. The question was administered to 36 respondents who are directly involved in teaching and learning at OUT. Frequency was lower in the use of MOODLE because not all PwVI had access (Table 2).

The ICT plays an essential role in teaching and learning. One of the important contributions of ICT in the field of education is easy access to learning. With the help of ICT, students can now browse through e-books, examination results and papers, previous year papers and can also have an easy access to resource persons, mentors, experts, researchers, professionals, and peers all over the world.

In this regards the respondents were asked to mention at least three activities in the university that use ICT. Most of the respondents indicated that activity such as provision of lecture notes through e-learning platform, the use of email as a means of communication between teachers and students, provision of lecture notes through audio clips or files, application and admission of students through the use of SARIS, online registration of examinations and view of examination results through SARIS were the major activities which uses ICT. Each of these activities was mentioned by 32 out of the 36 respondents. Other activities mentioned where the use of a discussion forum and provision of assignments and tests through e-learning platform.

Table 4.1: Learning and Teaching Activities That Use ICTs

S.No.	Activity	Frequency
1.	Provision of lecture notes through LMS(MOODLE) and CD	32
2.	Communication between Lecturers and their students through email	32
3.	Teaching and learning through discussion forums in MOODLE	18
4.	Audio clips or files (such as those recorded for class lectures)	32
5	Assignments and test provided through Moodle	20
6	Online student application through SARIS	32
7	Online examination registration through ERS(Examination Registration System)	32
8	Upload and view examination results	32

The researcher then asked PwVI the kind of ICT device preferred or has confidence in using. This question is very important as each ICT devices have different ICT access needs. The PwVI indicated to have mostly used Mobile phones, screen readers, desktop computers and laptops (Table 3). A few were using eBooks and no one use scanner. This indicates that scanners are not popular among the PwVI. Use of screen readers and mobile phones is because with the current technology screen readers are installed in some mobile phone applications (Table 3). According to Kane, people with visual disabilities use a variety of strategies to adapt inaccessible mobile devices and successfully use them to perform everyday tasks and navigate independently (Kane *et al*, 2009). This is the case also in Tanzania, where persons with disabilities use mobile phones (Mnyanyi, 2012).

Table 4.2: Distribution of ICT preference of PwVI

S. No.	Items	Not yet used	Rarely	Frequently
1.	Desktop computer	1(7.1%)	5(35.7%)	8(57.1%)
2.	Laptop computer	1(7.1%)	8(57.1%)	5(35.7%)
3.	CD/DVD	1(7.1%)	13(92.9%)	0.0
4.	Mobile phones	0.0	0.0	14(100.0%)
5.	Printer	1(7.1%)	13(92.9%)	0.0
6.	Screen Reader	1(7.1%)	0.0	13(92.9%)
7.	Scanner	14(100.0%)	0.0	0.0
8.	E-books	1(7.1%)	0.0	13(92.9%)

One of the respondents said this when asked on his favorable ICT

> *"Although I use mobile phone a lot for making and receiving calls, I myself prefer screen reader for learning and communication as this tool reads for me everything in the computer."*

4.4 ICT-access Needs of PwVI at OUT

The utilization of information and communication technologies, including the web-

based application, in open and distance learning (ODL) education is acknowledged worldwide (Mnyanyi & Victor, 2015). The demand of ICT skills at the OUT is high. To succeed at the OUT, students must acclimatize to the broad use of e-learning (that is, technology (ICT) used by instructors to support the learning process), including PowerPoint presentations in class, web-based email application, Student academic records information system (SARIS) a web-based application for recording all student's information, and the full range of information and communication technologies that instructor use when teaching courses entirely during face to face, entirely online, or in a combination of both (Mnyanyi, Bakari & Mbwette, 2012). In general, the modern learning atmosphere, students is anticipated to download course materials from dedicated learning management systems such as MOODLE as with the case of OUT; and make presentations using PowerPoint.

To this extent the researcher was interested first to know the needs of the PwVI in accessing ICT at OUT and then to find out if those needs are adequately met. In general the results in Table 4, show that the needs of the PwVI in accessing ICT are fairly met at the university. The PwVI indicated that the needs for availability of Assistive Technology (screen readers) in the Computer Labs, availability of eBooks and provision of technical support when required were seems to be fairly met (Table 4). The needs such as the provision of special training for PwVI and the accessibility of information system were seem to be poorly met (Table 4). This indicates that the screen reader (NVDA) as assistive technology is freely available as open source software therefore can be installed on any operating system available at the university. The only exception that hinders this technology to be available in every

computer at the university is the lack of technical knowledge for installation and configuration, and the condition of the computer hardware (old model, old version and very slow). The needs of special ICT training for PwVI are fairly met because although there is a special unit at the university that deals with the welfare of the disable people, these kind of training are seldom done and are often conducted at the headquarter. The information systems available at the university are poorly accessible because they were not designed or developed or purchased with the PwVI as one of the user in mind. This is because most of the information system contents are not accessible or understandable by PwVI when using screen readers.

Table 4.3: Needs of PwVI in Accessibility of ICT

No.	Needs	**Excellent**	**Fair**	**Poor**
1.	Provision of Special Training for PwVI	3(21.4%)	5(35.7%)	6(42.9%)
2.	The availability of computer technologies(Screen Reader) in general-use computer labs, specialized labs or centers for students with disabilities labs	2(14.3%)	8(57.1%)	4(28.6%)
3	The availability of electronic-format course materials (such as Word, PDF, and MP3)	3(21.4%)	6(42.9%)	5(35.7%)
4.	Computer hardware and software available at the university use by PwVI	1(7.1%)	10(71.4%)	3(21.4%)
5.	The technical support provided for computer technologies, especially assistive Technology	2(14.3%)	9(64.3%)	3(21.4%)
6.	The accessibility of Information systems which are used for educational activities such as SARIS, email and MOODLE	0.0	2(14.3%)	12(85.7%)

As part of the needs to be established, table 4 item number 1 shows that special ICT-access training are very rarely done. These trainings are meant to teach the PwVI how to use email, SARIS and MOODLE. These kind of trainings are necessary even

if the PwVI are ICT literate as they increase the accessibility of those ICT at OUT. One of the respondents who was computer literate said that

> *"I would very much like to know how to operate a computer so that I can get learning material from the computer, view my examination results using SARIS, because now I have to ask someone to view my results for me which is not nice as these things are private. But our computer training was conducted in Dar-es Salaam and I am in Shinyanga regional center so I could not make it. I plead to the University management to conduct these kinds of trainings in the regional centers".*

4.4.1 System Administrator's Skills and Education on PwVI ICT-access

With proper understanding of Web accessibility, legal requirements, and how to design and program for Web accessibility, a system administrator has a much higher probability to produce an accessible ICT application (Byerley & Chambers, 2003). An understanding on how to correct these issues was needed where the system administrator's accessibility knowledge was essential in effectively solving these problems (Bevan & Ahmed, 2007). The availability of competent technical support of the system administrators/developers is part of the needs to be established by the researcher. To this extent the researcher was interested to know system administrator's skills and education in ICT-access (web-based application accessibility). There were eight respondents to these questions. All of them were given to university system administrators. Out of eight system administrators/ developers, none of them have attended any formal training on web-accessibility. These findings were also found to be true by reviewing the CVs, academic certificates of the system administrators and the curriculum of the universities where the system administrator graduated (APPENDIX F1 and F2). The study also revealed that the system administrator in spite of being not attended any formal training on

web accessibility; they can provide temporary solutions. One of the system administrators responds when asked his educational background on ICT web accessibility and skills.

> *"Although I graduated at the University of Dar Es Salaam in 1997 in computer science, I never learned ICT web accessibility. I learned this ICT accessibility when I was confronted by a PwVI who encountered web inaccessibility. The PwVI was using a screen reader (NVDA) to access email system and he reported that he always encountered some navigation problem. Sometime he could not read any downloaded PDF files from the email system; he could not change his/her password."*

4.4.2 Organizational Administration and Policies on PwVI ICT-Access

The literature review section stated the need for university policy, administration, and leadership to address the need for accessible ICT. The researcher was interested to know if there is any policy or legislative documents that guide or direct that all ICT should be accessible to PwVI. The researcher was also interested to know if there are any informal guidelines or initiative to make web-application accessible to PwVI. The researcher was also interested to know the experiences of system administrators in developing web-based application which is accessible to PwVI. To find out if the institution (OUT) is very much committed to the issue of web-based application accessibility to PwVI the researcher wanted to know if in the ICT curriculum of web application development, the issue of accessibility is included.

In general a total of 5 management personnel were asked if there are any documents that stresses that all ICT should be accessible to PwVI. All of them respond that there are no documents that mention the use of ICT with PwVI or even so the disabled. The researcher also went through various documents to confirm this. The

researcher was also interested to know that if they consider system administrator during hiring who have the experience with accessibility of ICT to PwVI. All respondents pointed out that they are not aware of such details. One of them said that

> *"If we want to hire a webmaster, we ask people from IT directorate to prepare the job advertisement. We don't involve ourselves with the fine details of the job description of a department or faculty."*

The researcher also went through the past job advert, professional qualification and CV for the position of the system administrator to check if any of them have the experience in dealing with ICT accessibility issue related to PwVI. In general no one was found to have such qualifications.

4.4.3 ICT Instructors and Students on PwVI ICT-Access

To examine the university's commitments and availability of ICT policy of the university in dealing with ICT access in supporting ICT use by PwVI, the researcher asked 36 ICT instructors and students whether the issue of ICT accessibility is included in the University ICT curriculum. The study showed that all 36 ICT instructors and students confirmed that the university is not preparing its ICT students to become expert in ICT accessible solutions (APPENDIX F2).

4.5 PwVI ICT accessibility Challenges and Solutions at OUT.

While there is a growing use of ICT in learning and working environment at the Open University of Tanzania, there are still a number of problems that need to be addressed. More of those challenges are faced by PwVI when using ICT. For PwVI to benefit from the advantages of ICT in education, those problems/barriers need to have ICT solutions as quickly as possible.

To this extent the researcher was interested to know all the ICT accessibility problems encountered by PwVI and if the solution especially the ICT solution provided are compatible. In this case an open-ended questionnaire was administered to both PwVI and System Administrators/Developers to establish the problems encountered by PwVI when accessing ICT and compatibilities of the ICT solutions provided. Hence the respondents were asked to give at-least three problems encountered when accessing ICT and the compatibility of the ICT solutions provided. The results indicate that e-mail, website, SARIS, and course-related files in Word to be generally quite accessible. On the other hand, it was indicated that videoconferencing technology, online tests and assignments, CD-ROM tutorials, and online content using Flash (a multimedia platform that is used to add animation and interactivity to web pages) were poorly accessible. It was also indicated that many forms in the MOODLE were not accessible to the participants. Table 5 shows the accessibility problem mentioned.

Table 4.4: ICT Accessibility Problem Reported by PwVI

S. No	Problem (N=14)	Frequency
1.	Inaccessibility of lecture notes in the MOODLE and university website which are in pdf	4
2.	Inaccessibility of email (Google and Zimbra mail server)	8
3.	Inaccessibility of MOODLE and SARIS	8
4.	Inaccessibility of Audio clips or files (such as those recorded for class lectures)	6
5	Assignments and test provided through MOODLE	6
6	Online content that uses Flash	6
7	Lack adequate knowledge in using Assistive Technology	5
8	Inaccessibility of institution website	1

Inaccessibility of email and MOODLE posed problems for all the participants. Participants commented on the inaccessibility of some course notes and materials,

including those in PDF (portable digital format) and PowerPoint. The participants also indicated that the lack of needed adaptive computer technologies was a problem, as was their own inadequate knowledge of Adaptive Technology. Time limits for online test and assignments, while technical difficulties in internet connection for those who are at the regional center posed a major problem.

Table 6 shows ICT solutions to the problems experienced with accessibility problem that were reported by the participants. Although the most common response indicated was that the accessibility problems is as a result of poor system design and thus there was no immediate solution and hence remained unresolved. A number of solutions were commonly mentioned, including using other formats, devoting more time and effort to learning how to use Assistive technology, and allowed to take more time when doing a test or assignment than the rest of the class.

Table 4.5: ICT Accessibility Solutions Given to PwVI

S. No	Solution	Frequency (%)
1.	Accessibility problems is as a result of poor design and thus there is no immediate solution and hence remained unresolved.	26(61.9%)
2.	Request another format, of course notes to be uploaded by the course lecturer.	9(21.4%)
3.	Devoting more time and effort to learning how to use Assistive technology	6(14.3%)
4.	PwVI to be allowed to take more time when doing a test or assignment than the rest of the class	1(2.4%)

One of the System Administrator gave a description of ICT accessibility problems but did not provide any solution.

> *"Most of the time PwVI complained that the screen reader cannot detect an image, map or a graph. This is because screen reader only reads text. For this reason, one PwVI reported that there is no indication that he is really logging into University email. This is so because the welcoming text is rather an image."*

The working solution for this kind of problem is to add a simple HTML code to provide a text for each image and graph. Figure 6 shows the HTML code. The word in the <img> (HTML TAG) should fully fit the description of the image.

HTML with problem
<img src="outlogo.gif" width=”200” height=”250”></p>
Correct HTML code
<img src="outlogo.gif" alt="Open University of Tanzania Mail System"> </p>

Figure 4.2: HTML Code to Solve the Image Accessibility

The System Administrator went on to describe other problems as follows

> *"Most of the lecturer uploads their course notes through MOODLE in the form of a pdf. But most of the pdf or other image like documents cannot be read by screen readers."*

The working solution for this kind of problem is to always provide an alternative text-based format for every PDF document. The System Administrator went on

> *"Due to the increasing number of uploaded lectures in the form of videos and other multimedia format, PwVI cannot see the videos or images display in that video. So I always advise those who make those multimedia lecturers to incorporate text or voice that fully describe the images in the video. Another reported problem was that the link to change user profile was not accessible."*

Another challenge was that, it takes a lot of time for PwVI to navigate in the system. This kind of a problem can easily be solved by having an alternative link or keyboard shortcut for every major function of the system. The scenario being that, since PwVI

cannot use pointed devices like mouse, it is very difficult and time consuming to find something in the system. To solve this problem a javascript (figure 6) was design to invoke any controller in the system. Figure 6 shows an example of the javascript to invoke a function to change user password. This javascript will be invoked whenever F10 key is pressed by a student using SARIS. And in turn, it will run a controller called chpasswd which will display the form to change the password of the student. In an interview with one of the PwVI respondent who is both a student and staff said that

> *"You know I was trained very well in using the email system; I was able to receive and send email and even change my password. But when the University changed to a new email system, I heard it called Zimbra. I spend more than one month without accessing my email account until one IT guy came to my rescue. Even up to now I cannot change my password on my own."*

The solution to this problem is to provide a keyboard shortcut that will invoke password change form. The javascript provided in figure 7 could have solved the problem. But the problem is that the source code of the email system is locked and therefore the solution cannot be applied.

```
$(document).ready(function(passwdc){
   $(document).keydown(function(passwdc){
varkeycode = passwdc.keyCode;
      if (keycode == 121) {
document.location.href='<?php echo base_url()."index.php/chpasswd";?>';
      }
   });
});
```

Figure 4.3: Javescript To Provide Shortcuts to Password Change Link

AChecker is an automatic web accessibility verification tool and is usually used to examine web-application to point out accessibility discrepancies and suggest necessary technical solutions. The new email system was examined and the output below shows the output of the AChecker (check 189).

Check 189: **label** may not describe its associated control.

Line 50, Column 33:
<input type="hidden" name="loginOp" value="login"/>

Line 56, Column 57:
<input id="username" class="zLoginField" name="username" type="text" value="" size="40" maxlength="1 ...

Line 61, Column 49:
<input id="password" autocomplete="off" class="zLoginField" name="password" type="password" value="" ...

Line 67, Column 49:
<input id="remember" value="1" type="checkbox" name="zrememberme" />

Line 69, Column 49:
<input type="submit" class="ZLoginButtonDwtButton" value="Sign In" />

Figure 4.4: ACheaker Output of the Email System

This AChecker output check shows that there are five accessibility problems at check 189. These problems are described by the link labeled “label may not describe its associated control”. This means these form inputs do not have any descriptions associated with them. Therefore, if a PwVI is using a screen reader and it reaches line 56 where the PwVI is supposed to enter his/her username, the screen reader will remain silent. Each of those checks has a recommended solution on clicking the link. Take for example, check 189.

ELEMENT
input
ERROR TYPE
Potential
GUIDELINES
WCAG 2.0 (Level A)
↳3.3 Input Assistance: Help users avoid and correct mistakes.
↳Success Criteria 3.3.2 Labels or Instructions (A)
REQUIREMENT
Each label describes its associated input element.
ERROR
label may not describe its associated control.
SHORT DESCRIPTION
Each label must describe its associated input element.
HOW TO DETERMINE

Question	Does this label describe its associated control?
PASS	label describes its associated control.
FAIL	label does not describe its associated control.

STEPS TO CHECK
Procedure
1. Check all input elements and view their associated label.
2. Note: For information on what constitutes an associated label please see test 57.
Expected Result
1. Each label is expected to describe its associated input element.
Failed Result
1. Modify the label text so it describes the purpose of the input element.
Examples
Pass Examples
label does describe its associated input element.

Line 50, Column 33:
<label for="name">Login Operation:</label><input type="hidden" name="loginOp" value="login"/>
Line 56, Column 57:
<label for=" username">username:</label><input id="username" class="zLoginField" name="username" type="text" value="" size="40" maxlength="1 ...
Line 61, Column 49:
<label for=”password">password:</label><input id="password" autocomplete="off" class="zLoginField" name="password" type="password" value="" ...
Line 67, Column 49:
<label for="remember">Remember Me:</label><input id="remember" value="1" type="checkbox" name="zrememberme" />

Figure 4.5: ACheaker Output of the Email System with Details

Implementing all those checks will render the web-based application system to be more accessible to PwVI.

CHAPTER FIVE

5.0 FRAMEWORK FOR DESIGNING ACCESSIBLE ICT

5.1 Introduction

As part of the solutions for ICT accessibility to be established as well as the main contribution, this study propose framework which will help in acquiring or designing accessible ICT. As a result, this chapter presents two frameworks. These frameworks are as a result of the findings of the study. The frameworks are operational framework and software framework.

5.2 Operational Framework for Acquiring Accessible ICT for PwVI

In the usage of ICT there are both advantages and barriers especially for PwVI. One of the barriers is the fact that the deployment of a certain kind of ICT may result in a negative outcome (ICT inaccessibility) in the learning and teaching environment at OUT. As suggested in the literature review (Byerley & Chambers, 2003; King *et al*., 2005), it is very essential and advantageous to assure that for all key significant factors serene to successful deployment of ICT are effectively observed and addressed. These factors need to be identified, analysed and then adequately controlled in the deployment process. ICT inaccessibility, as one of the factor in the successful implementation of ICT in teaching and learning is analysed and discussed in this study.

Based on the literature review (Milne *et al*., 2005), there are factors that contribute to ICT accessibility to visually impaired persons related to technical and in general,

policy issues. These factors have been partly addressed in research question 2 and research 3. This subsection will give the framework at the institutional level that will help the institution to acquire accessible ICT. This framework will act as a guideline for OUT to acquire accessible ICT and offer an instrument to identify and analyse the possible undesirable effects of inaccessible ICT.

Figure 9 shows a framework illustrating an educational system at OUT with various factors that affects ICT accessibilities. In this respect, the technical aspects that are involved in the framework are the ICTs. These include the computer systems, information systems (web applications) and the assistive technologies (screen readers). The figure shows that the introduction of ICT in the university will affect the way teaching and learning processes are conducted. These new ways will inevitably have some effect on students, teachers and other users at the university. These effects may be positive or negative. The positive effects are so because, the introduction of ICT was meant to help the OUT society to be efficient, flexible and reducing cost in the learning and teaching activities. The following are the key factors that influence ICT accessibility as was mentioned in the literature review as well as the data collected to address research question 2 and 3.

i) Availability of assistive technology (AT) in all computer labs (addressed in research question 2).
ii) Regular training to PwVI on ICT available at the university (addressed in research question 2).
iii) ICT accessibility knowledge of system administrators (addressed in research question 2 and literature review).

iv) Knowledge of Web Content Accessibility Guidelines 2.0. (WCAG 2.0) that helps in designing accessible ICT (addressed in research question 3 and literature review).

v) Institution's policy and regulation (literature review).

The negative effects are shown in Figure 9 as the new ICT accessibility needs. The willingness to change the key factors may reduce the ICT accessibility needs and problems. This can be done by changing the factors such as, introducing new ICT accessibility policy in the already existing ICT policy of the institution and provide regular training for PwVI on deploying information system.

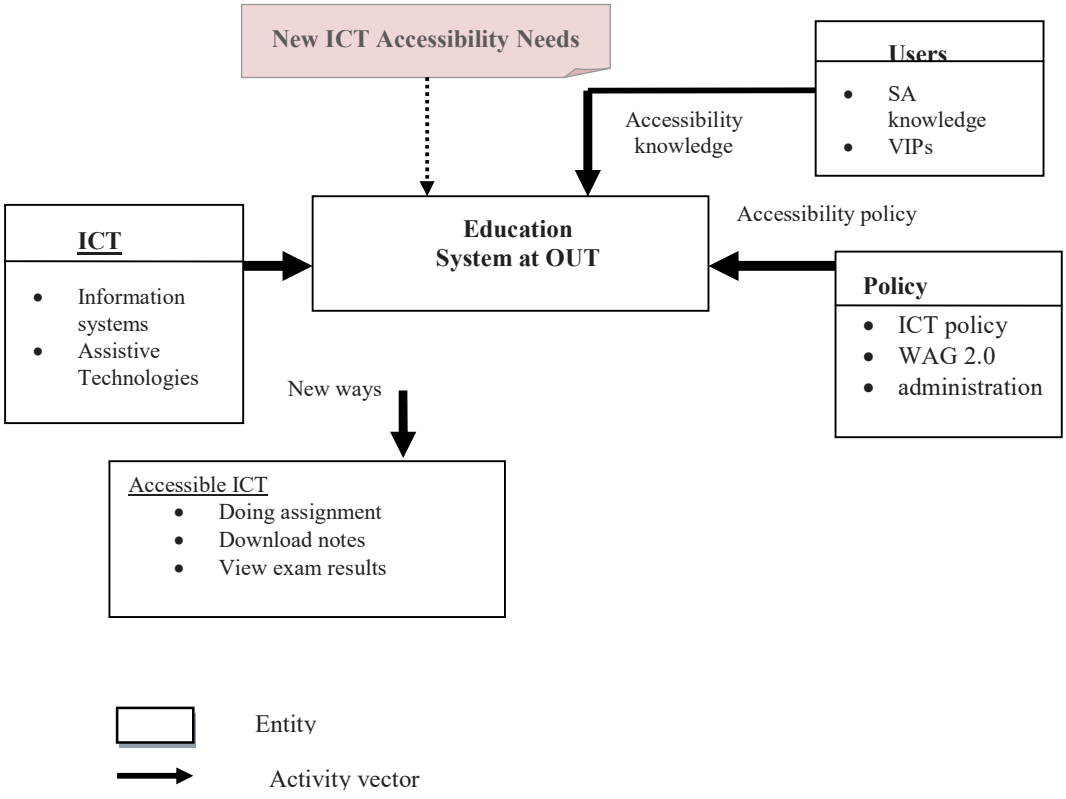

Figure 5.1: Operational Framework for Acquiring Accessible ICT for PwVI

5.3 Software Framework for Designing Accessible ICT for PwVI

This study under research question 2 and literature review (Bevan & Ahmed, 2007) indicated that part of the needs to be established in order to develop accessible ICTs is to have competence personnel in ICT accessibility knowledge. But the study shows that there is no system administrator at OUT with such competence or the W3C accessibility guidelines. As such, it is difficult and impossible to develop accessible ICTs using in-house system administrators. As a contribution and a main objective of this study, a software framework was proposed. This software framework will help system administrators/developers in rapid development of accessible ICTs.

In this subsection we discuss the proposed software framework in Figure 10 and its components to design ICTs which can be accessed by PwVI. The framework follows the 3-tier architecture model. In this architecture the system components are arranged into three physical tiers namely client, application and database layers. Usually the database employed is the Relational database management system. The application layer contains the business logic, running on a server and communicates with the client using HTTP. The client on the web applications is a web browser that runs HTML generated by the application layer. This is generally considered a good practice as it modularizes code, promotes code reuse, and allows multiple interfaces to be applied (W3C2, 2010). This is very important in ICT applications, as it will allow more than one view to be presented, such as website for humans, and remote access applications interfacing.

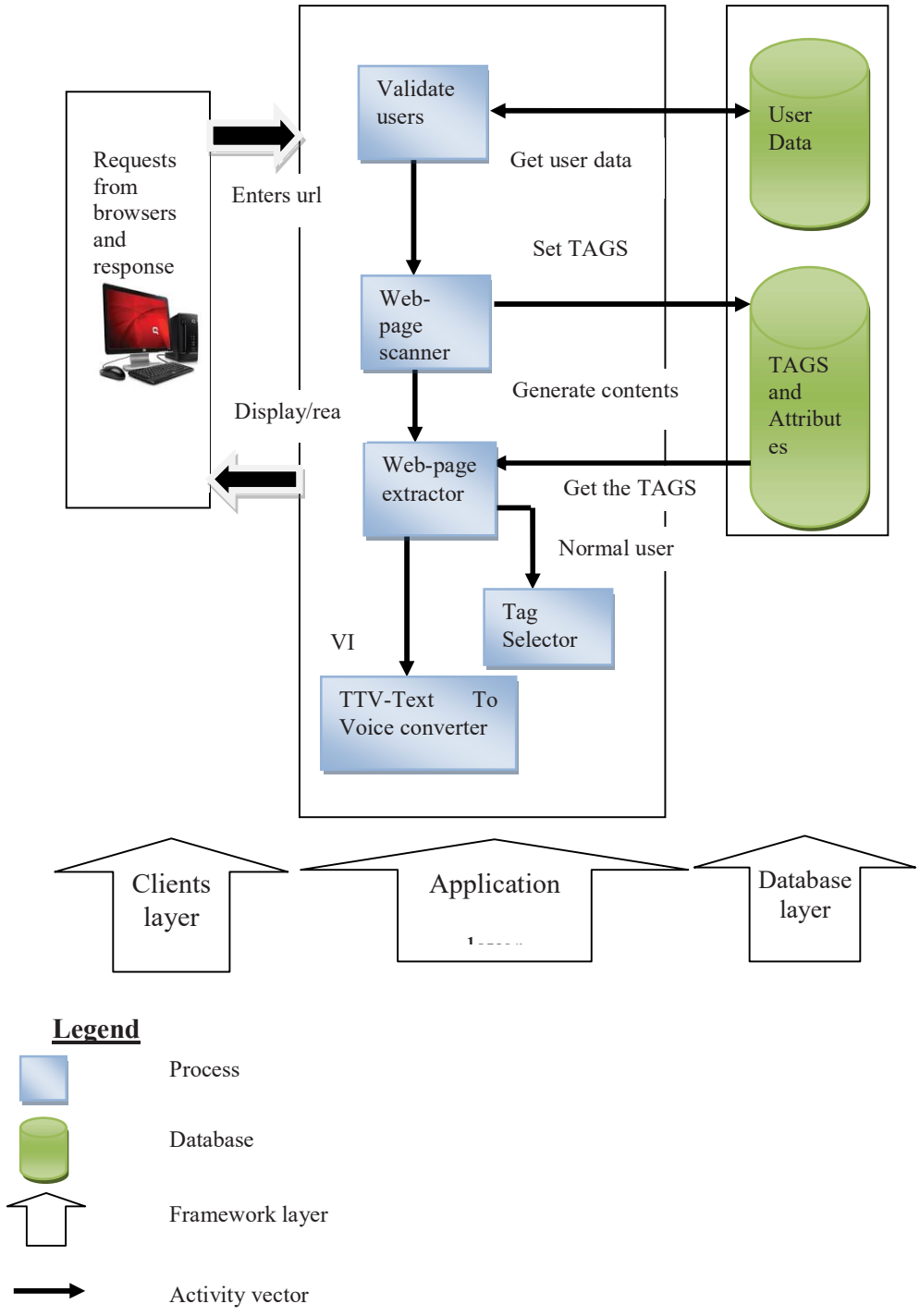

Figure 5.2: The Block Diagram for the Software Framework

Client Layer: this is the layer in which the user communicates with the whole system. The user clicks or enters the URL and then enters his/her credentials. Through the user ID, the user disability condition will be identified and the appropriate output will be displayed through this layer (either normal webpage display or the text is converted into voice).

Application Layer: This layer has several components.
User validation component: checks the user ID entered from the client layer check if the user exists and then finds the user disability status.

User data: this is the database tables that contain all information about the user, including usernames, user ID, email, physical address, and disability status.

The Web page Scanner: this component opens the necessary Web page and scans its content, the contents are then sent to page extractor.

The Tags and Attribute Database: All the tags and attributes from the scanned Web page are inserted into a database so that they can be used later by web Page Generator.

The Page Generator: It filter component eliminates each tag in the extracted content and returns with only the pure page content. Then the component checks the disability status of the user. If the user is PwVI the page is sent to the Text To Voice convertor (TTV) otherwise the page is left as it is.

Text To Voice (TTV) converter: TTV is an external application service that is used within the framework. (If the user is a blind) the page is spoken loudly by converting the page contents to voice.

The framework starts by a user logs into the system by entering the URL of the required web page. The system checks the database to find if the user exists and also finds the disability status of the user. The system then scans the entire page to get the HTML TAGS and store them in the database which will be retrieved letter for page generation. The contents of the scanned page are then extracted by the system. If the user is PwVI, the content is converted to voice using the external TTV module if there is no Assistive device plugged; otherwise the content is displayed on the screen.

5.4 Prototype Based on the Proposed Software Framework.

This subsection will present a website designed using the framework presented earlier in section 5.2. The website was developed using PHP and JavaScript as a scripting language. Mysql was used as a database with MyISAM as its engine. The prototype was planned to run on the apache 2.0 web-server. The cost and time of revamping the current university website to be accessible is very large. A separate accessible website was created. The new accessible website contained all necessary functions and links that are important for university students. This website was created using Joomla framework. The Joomla framework was choosen because the researcher’s competence on this framework. The accessible model was designed to use both websites.

There are two versions of this prototype. One will be used by students to access university website and the other will be used by non-students. The first version utilizes the fact that all students are known and identified by the university. The system uses SARIS login information which has the student's disability status. This prototype will present the student with the login screen. This page was tested by ACheaker and found to be 100% compliant to WAG 2.0. Figure 12 shows the screen shot of the login screen. Once the student enters his/her username and password, the prototype will identify his/her disability status and will be directed to the appropriate webpage. If the student disability status field is equal to one, he/she will be directed directly to the new accessible web page. Otherwise, the student will be directed to the normal web pages.

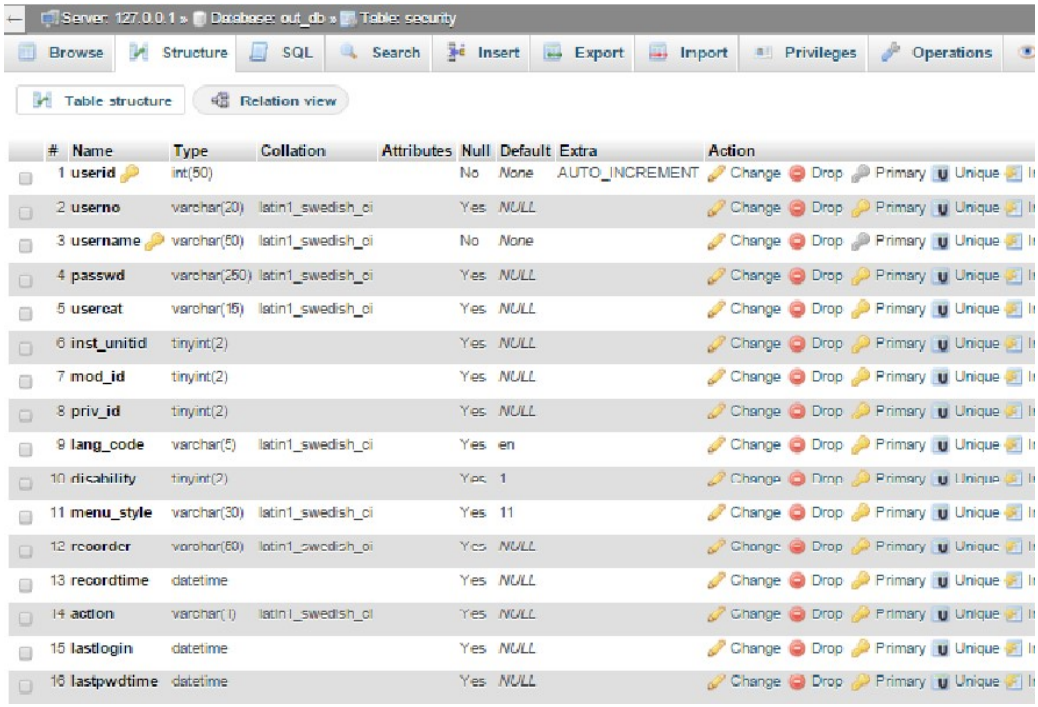

Figure 5.3: SARIS Login Information with Disability Field as Disability Status

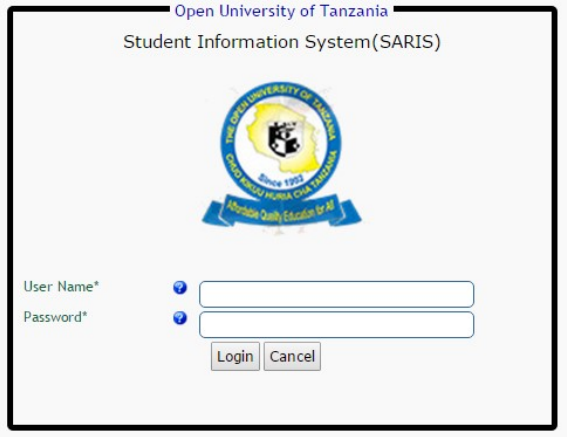

Figure 5.4: SARIS login screen

The model was created using codeigniter 2.0 framework. This is a lightweight and rapid web-application development framework which utilizes PHP, JavaScript and mysql database. This framework uses Model-View-Controler (MVC) where business processes separate from data presentation. This framework was chosen because the researcher's competence on this framework. Figure 13 shows the method of the controller, which is used to validate the username and password of the student. The method captures the username and password from the login form. Other user information is then fetched from the database using these credentials. The fetching is done by calling a codeigniter model name user. Figure 13 line 55 shows how to call the model from the controller. The codeigniter model to fetch user data from the database is shown in figure 14. Line 56 of figure 14, the controller test if the credentials exist in the student database. If the credentials are wrong a message will be displayed showing the either the username or password is wrong. Otherwise the controller tests the disability status. If the student is disabled, he/she will be directed

to the special accessible website for disabled, otherwise he/she will be directed to the normal university website.

```
function check_database($password)
{
  //Field validation succeeded.  Validate against database
  $username = $this->input->post('username');
  //query the database from user model
  $result = $this->user->login($username, $password);

  if($result)
  {
    $sess_array = array();
    foreach($result as $row)
    {
      if ($row->disabled==1) {
          redirect('www.out.ac.tz:2020','refresh');
      } else {
          redirect('www.out.ac.tz','refresh');
      }
    }

    return TRUE;
  }
  else
  {
    $this->form_validation->set_message('check_database','Invalid username or password');
    return false;
  }
}
```

Figure 5.5: Method of the Controller to Validate the Username and Password

```
<?php
Class User extends CI_Model
{
    function login($username, $password)
    {

        $this -> db -> select('userno, username, passwd,usercat,security.mod_id as mod_id,mod_dir,mod_name,usermod,inst_unitid,blocked,priv_id,disabled');
        $this -> db -> from('security');
        $this -> db -> join('modules','modules.mod_id = security.mod_id');
        $this -> db -> where('username =' . "'" . $username . "'");
        $this -> db -> where('passwd =' . "'" . MD5($password) . "'");
        $this -> db -> limit(1);
        $query = $this -> db -> get();
        if($query -> num_rows() == 1)
        {
            return $query->result();
        } else {
            return false;
        }
    }
```

Figure 5.6: Method of the Model to Fetch User Information

In the second prototype, the screen will be presented that have a keyboard option to go either the accessible web page or the normal website. Figure 15 shows the screen

shots that have the two options. Figure 16 and figure 17 shows the accessible and normal websites respectively.

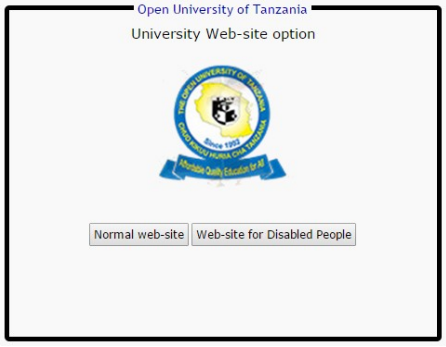

Figure 5.7: SARIS Login Screen

Figure 5.8: Normal Website

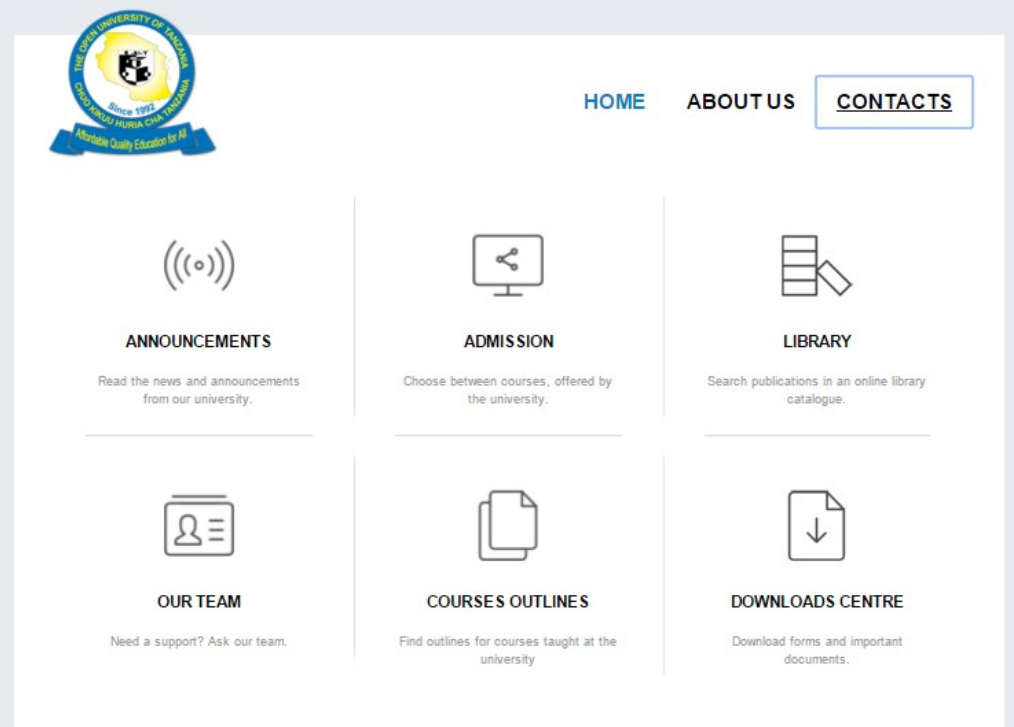

Figure 5.9: Accessible Website for Disabled

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents a summary of study key empirical findings, conclusions and recommendations for practices and future study. The assessment was through the analysis of the interviews conducted with students and staffs who are PwVI, system administrators/developers, ICT teacher and students and the management.

6.2 Summary of the major findings

This study responds to the need for solutions to the ICT-access problems faced by PwVI in accessing or using ICT, especially web-based applications at the Open University of Tanzania. I approached the problem domain with three research questions:

i) "What are the learning and teaching activities that use ICT, including web-based application?".

ii) "What are the needs of PwVI when they need to access ICT?"

iii) "What are the problems faced by PwVI in using ICT and their corresponding solution?"

iv) "What can be done at OUT to have accessible ICT for PwVI?"

To answer the research questions, three research objectives: to find the learning and teaching activities that use ICT in the University; to find out the ICT-access needs of PwVI; and to establish the ICT-access problems of the PwVI and to assess the compatibility of the solutions provided. Investigation, analysis and interpretation of

the primary and secondary information about the study showed the findings which are summarized below as follows.

6.2.1 Teaching and Learning Activities that Uses ICT at the University

The adoption and use of ICTs in education have a positive impact on teaching and learning (Noor-UL-Amin, 2013). Noor-UL-Amin went on to elaborate that ICT can affect the delivery of education and enable wider access to the same. In addition, it will increase flexibility so that learners can access the education regardless of time and geographical barriers. It can influence the way students are taught and how they learn. In this study, it shows that although the PwVI are having problem of accessibility, but they use ICT for communication (email system), online assignments and tests (MOODLE), download of lecture notes, and view academic results and online registration. This study also shows that OUT as a online learning institution, it uses ICT in various other activities including online application and admission of students, movement of files from one office to another, library daily operation and paperless meetings.

6.2.2 ICT Access Needs of the PwVI in using ICT and Their Fulfilment

ICT can influence the conveyance of education and empower more extensive access to the same. What's more, it will expand adaptability with the goal that learners can have access to education regardless of time and geographical barriers. It will have a positive affect the way students are taught and how they learn. For students and teachers to enjoy the benefits of ICT in learning and teaching activities, their ICT-access needs should be extensively fulfilled. This study revealed that the ICT-access

needs, especially for PwVI are fairly met by the University. The study revealed that there is inadequate PwVI special training on ICT. These kinds of trainings are very important as it will enable the PwVI have knowledge of how to access and navigate through the software like MOODLE. The study also revealed that there is inadequate availability of computer technologies (Screen Reader) in general-use computer labs, specialized labs or center for students with disabilities labs. Only computers with screen reader installed are the once that can be used by the PwVI. But the study shows that screen readers was only installed on ASTU-DAAT computer room (computer lab for disabilities). General computer labs, including those at the regional centers do not have screen readers and hence cannot be used by PwVI.

The use of e-learning platform (MOODLE) at the university will ensure that students, regardless of geographical location or time can download course materials in electronic format. The study shows that at the university the availability of electronic-format course materials (such as Word, PDF, and MP3) is very inadequate, this is because most of the course materials for most academic programs have not been digitized. And even those which have been digitized, most of them cannot be read using screen readers. This is because most of these course materials were created by scanning the hardcopies and therefore creating image PDF instead of characters PDF which can be easily read by screen readers.

To have full ICT access the university in general should have sufficient number of computer hardware and software which are compatible to PwVI. This study shows that there is an inadequate number of computers with the necessary software

compatible to PwVI. This is because the only computer lab, which is compatible (computers installed with NVDA screen reader) to PwVI is the one situated at the Kinondoni Center of the Open University Tanzania. This computer lab has thirty computers with screen readers installed. There is also special training on PwVI for non university students, which make it difficult for university students to have full access to the lab.

Research from a number of disabled young people, their families and schools shows that access to and interfacing with, assistive technology needs continual training, development and support (Wilson & Wilson, 2001). It is expected that the PwVI would need a lot of support when accessing ICT. This study shows that there is inadequate technical ICT access support provided by the university to PwVI. This is because most of the solutions provided by the technical ICT personnel are not compatible to the problems faced. It was also revealed that the needs of ICT for PwVI are fairly met in terms of ICT training on accessibility and technical support. The study revealed that technology needs were not particularly well met in the following situations: when taking distance education courses, when looking for help related to information and communication technologies, when attempting to access the library's information systems, and when their instructors used e-learning materials.

An understanding on how to solve the problems of web based application accessibility was essential, where the system administrator's accessibility, education was essential in effectively solving those problems (Bevan & Ahmed, 2007). The

study revealed that the system administrator at the University had no previous formal training or knowledge on the issue of web based application accessibility. It was also observed during the study that there is no policy or legislative documents that guide the university towards using ICT which is compatible to PwVI. The guideline would have been very important as it will direct for example the instructor to upload lecture notes in accessible format; the hired system administrator should possess ICT accessibility experience.

6.2.3 Solutions and compatibility to the access needs of PwVI in using ICT

The use of ICT at OUT have faced many challenges related to how best to use ICT. More problems, especially of accessibility are related to the use of ICT for persons with disabilities, especially those with visual impairment (Mnyanyi & Mbwette, 2009). There are also challenges related to delivery mode of content, formats and its layout that needs to be accessible to all persons, including persons with disabilities (Mnyanyi, Bakari & Mbwette, 2012).

This study shows that most of the challenges reported by the respondent were inaccessibility of web-based application (including websites, and MOODLE, SARIS and Email). This was the most common challenge mentioned at least once by all the participants. This is hardly surprising given the fact the university is delivering most of its services through the use of ICT. This shows both accessibility and usability challenges are common in web-based application that includes MOODLE, SARIS and email systems. The accessible nature of these systems could be caused by both to software design issues as well as to the content put into the systems. Therefore

problems in this realm could be due, for example, to the accessibility issues of the web-based application deployed (including an interface/form which cannot be accessed using adaptive software such as screen readers); two usability issues such as the content cannot be understood (like when a screen reader tries to read text arranged in an HTML table); to inaccessible content, such as image PDFs which a screen reader cannot read it and video clips which has no caption.

In response to the web-based application inaccessibility, it was mostly reported by 61.9% of the total solutions given by PwVI that there was no ICT solution to rectify the situation. The solution given was mostly non ICT like to let someone else do the activity on his/her behalf. This is because the problem lies in the application software. This means that in most cases something has to be done in application software like customization according to the recommendation given by Web Content Accessibility Guidelines 2.0. (WCAG). There are two reasons why these recommendations cannot be implemented to solve the application software at OUT. First, although the software applications available at the university are all open source, there is no system administrator who saves competent with the source code use SARIS. This means with the exception of SARIS no other application software can be customized to remove the inaccessibility. The study revealed that the software application deployed at the university was developed or purchased without putting into consideration the special needs of the people with visual impairments.

Another less popular problems reported is inaccessibility of lecture notes in PDF, audio clips or files (such as those recorded for class lectures). Online content that

uses Flash (taped lectures) is becoming more popular in delivering lectures are also reported to have accessibility problems. Although most free computer based video players (like Windows Media Player) are capable of displaying subtitles, most digital videos needed by students are not captioned, making them inaccessible to PwVI. The lack of a narrative regarding what is available on in the video will render it inaccessible to PwVI. The same is true for online lectures and other multimedia materials which are generally do not have subtitles. The inaccessibility of PDF always depends on how the PDF was created. Faculty and departments often scan old, heavily annotated study materials in paper form and distribute these to students in PDF format. Scanning always produces a PDF document consisting of images of the scanned pages. Visually impaired students who use screen reader are unable to access these kinds of documents since there are no words to read.

For inaccessibility of electronic documents, the non ICT solution was always given as to tell someone else to read the electronic document for him/her. ICT solution was given as to provide or create an alternative format which will be accessible to PwVI. It is also good practice to provide lectures in PowerPoint or or any data projection methods before the lecture. This will allow the PwVI to have the document before the lecture.

Other ICT access problem reported are inadequate time provided for PwVI to do their assignments compared to non PwVI. By using screen readers to access MOODLE to do their assignments, the PwVI are bound to be slower than the non PwVI. To solve this issue, MOODLE should have the feature to give or allocate

different duration to the same assignment. This is not the case as MOODLE cannot allocate different duration for the same assignment. Therefore, different time interval was given to PwVI and the non PwVI. The solution given was just to give different time durations for the two groups. But the proper ICT solution was to customize MOODLE so that assignments can be given to the two groups in the same time but different durations.

Another problem reported was inadequate knowledge in using Assistive Technology in this case a screen reader. Technical knowledge on how to use screen reader is very important since screen reading is usually done in a group mode. A real time screen reading is required for web-based software application navigation. In order to activate the next Web page, the user still needs to point to a specific hypertext link and click the mouse, an action which is nearly impossible for a visually impaired person. So using any web application a PwVI needs to know the technical knowledge of the software like knowing the shortcut keys of the software. This will enable the PwVI to navigate through the software. The study showed that the ICT solution for this kind of problem is to devote more time and effort to learning how to use Assistive technology and regular training.

6.3 Conclusion

This study assessed solutions that support PwVI in accessing ICTs in educational activities. According to the findings of this research, it can therefore be concluded that; Information and Communication Technologies are widely applied in educational activities at OUT. Forms of ICTs used in educational processes include

emailing, getting lecture notes from e-learning platform, view examination results, computers and the Internet surf. The study shows that although the PwVI ICT literacy is high, but the ICT Access needs available at the University are not adequately met. This is because, although Information and Communication Technologies are widely used in educational processes, PwVI who are also involved in their educational processes as employees or students are not involved or considered during the implementation of ICT.

The study also shows that the solution provided at the university are not adequately compatible to be used by PwVI. This is because although there are Information Systems installed at the University as ICT Solution to automate some educational processes, these systems are not adequately accessible especially to PwVI. This study also revealed that the solutions provided by the system administrators/developers to solve the inaccessibility of the ICT problems encountered by PwVI are also not permanent. This is because most of the solutions at the study to solve accessibility problem were indicated as being unresolved. These systems need a lot of customization by following the guidelines recommended by W3C to make them accessible.

Thus the University needs to be enticed to consider ICT Solutions (Information Systems) which are compatible to visually impaired persons as individuals and members of the university community.

6.4 Recommendations

This study was conducted to establish the solutions to the problems faced in the use

of ICTs by visually impaired persons at the Open University of Tanzania. From the findings, this study is proposing the following recommendations.

i. Visually impaired persons should be highly involved during development or purchasing of the University Information system to improve accessibility.
ii. There is a need for University to set policies which will ensure there is availability of recommended ICTs for PwVI.
iii. Policies have to give more attention on raising awareness to the university community on ICTs which are compatible to PwVI.
iv. More training be provided either as short courses or imbedded in the ICT curriculum on ICTs which are responsive to PwVI.
v. The University should consider PwVI accessibility to ICT when hiring System Administrator/Developers.

6.5 Suggestion for Further Research

This study uses a majority of web-based applications which were student's center information systems. There is a need for this kind of research to be conducted on non-students based information system. There is a need also to conduct this kind of research in conventional universities in the country. The Researcher also recommends for further studies on the topic concerning with the demand of ICTs compatible to PwVI, the function of education on integrating PwVI to use ICT, the role of open and distance learning in facilitating ICT for PwVI, and development of ICT curriculum for PwVI in Tanzania and beyond. The study could also be conducted for other type of disability instead of only VI. A study to check the accessibility level of all ICT of the government institutions will also be relevant.

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APPENDICES

Appendix A: Questionnaire for Visual Impaired

Questionnaire to be Answered by PwVI in the University

I, Said Ramadhani Said, am a student of the Open University of Tanzania. As a requirement for an MSc ICT award, I am supposed to conduct a research whose findings will be represented to the university. I am requesting your cooperation by filling this questionnaire honestly and returning it to me. Information collected by this questionnaire is mainly for academic use, but may also be used for otherwise when required. The researcher is guaranteeing privacy of respondents and their enterprises.

1) What are the learning or teaching activities that involve ICT at OUT?

……

……

2) Did you receive ICT training when joining the University?

Yes ☐ No ☐

3) Are you familiar with ICT and Assistive Technology?

Yes ☐ No ☐

4) What is your preferred ICT and/or assistive technology?

……

……

5) What do you need in order to have access to ICT and are they met?

……

……

6) To what extent are your needs met?

Very extent ☐ Fairly Extent ☐ Poorly extent ☐

7) Do you receive regular ICT skills for Visual Impairment?

Yes ☐ No ☐

8) Do you encounter accessibility problems when using assistive technologies on ICT?

Yes ☐ No ☐

9) Where do you report such problem?

ICT Helpdesk ☐ Instructor ☐ System Administrator ☐

10) Do you get the response on time?

Yes ☐ No ☐

11) Do the support solutions you receive helpful? Give at least three problems you do face and the solutions you received.

……

……

……

……

……

Appendix B: Questionnaire for System Administrator

1) How do you describe your ICT skills?

good ☐ normal ☐ poor ☐

2) Do you know Assistive Technologies?

Yes ☐ No ☐

3) To what extent are your web-based application compliancewith User Agent Accessibility Guidelines (UAAG)?

Very extent ☐ Fairly Extent ☐ Poorly extent ☐

4) To what extent do you find solutions to accessibility problems encountered by users especially PwVI?

Very extent ☐ Fairly Extent ☐ Poorly extent ☐

5) Are there any web-application development policy guidelines in the ICT policy?

yes ☐ No ☐

6) To what extent do your university/college policies address regular or periodic Web application analyses to ensure UAAG conformance?

Very extent ☐ Fairly Extent ☐ Poorly extent ☐

7) Are you familiar with creating a web - application that is accessible for users with visual impairments?

yes ☐ No ☐

Appendix C: Questionnaire for ICT Teachers

1) Do you have Visual Impaired Student in your class?

Yes ☐ No ☐

2) What are the learning or teaching activities that involve ICT at OUT?

……

……

3) Are there any students, especially visual impaired that complain that ICT being inaccessible?

Yes ☐ No ☐

4) Are you familiar with Assistive Technology?

Yes ☐ No ☐

5) Are you familiar with User Agent Accessibility Guidelines (UAAG)?

Yes ☐ No ☐

6) Do your syllabus include curriculum to teach your students to develop accessible web-application especially for visual impaired?

Yes ☐ No ☐

7) Any suggestions to improve the delivery of education through the use of ICT, especially for visual impaired.

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Appendix D: Questionnaire for ICT Students

1) Do you have Visual Impaired Student in your classas a classmatee?

Yes ☐ No ☐

2) What are the learning or teaching activities that involve ICT at OUT?

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3) If yes, where do you inquire for ICT help when encounter with ICT accessibility related problem?

ICT Helpdesk ☐ Instructor ☐ System Administrator ☐

4) Are you familiar with Assistive Technology?

Yes ☐ No ☐

5) Areyour familiar with User Agent Accessibility Guidelines (UAAG)?

Yes ☐ No ☐

6) Is your syllabus emphasized on developing accessible web-based application?

Yes ☐ No ☐

7) Any suggestions to improve the delivery of education through the use of ICT, especially in the issue of accessibility.

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Appendix E: Questionnaire for Management

1). Are you involved in the decision making whenever there is a process of designing a web-application?

Yes ☐ No ☐

2) Do you play a central role in determining the ICT strategy for your institution?

Yes ☐ No ☐

3) Are there any ICT development policy guidelines in the ICT policy?

Yes ☐ No ☐

4) Are there any guidelines when hiring a system administrator to make sure they are qualified to design accessible ICT?

Yes ☐ No ☐

5) Any suggestions to improve the delivery of education through the use of ICT, especially for visual impaired.

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Appendix F1: B.Sc. in Computer Science curriculum–UDSM

B.Sc. in Computer Science		
First Year (Double Major)		
Code C	Course Title Credits Semester Core/Optional	Core/Optional
IS 142	Introduction to High Level Programming	Core
IS 151	Digital Circuitry	Core
IS 161	Basic Computer Applications	Core
MT100	Foundations of Analysis	Core
MT147	Discrete Mathematics	Core
IS 133	Systems and organizations	Core
IS 138	Social-Cultural Implications of Information Technology	Core
IS 139	Introduction to Computer Architecture	Core
IS 136	Programming in C	Core
IS 137	Data Structures and Algorithms	Core
MT 127	Linear Algebra I	Core
IS 243	Practical Training I	Core
Second Year (Double Major)		
IS 271	Computer Networks	Core
IS 272	Software Development I	Core
IS 245	Operating Systems	Core
EV 200	Environmental Science I	Core
IS 273	Unix Systems Administration in Linux OS	Core
MT 233	Mathematical Statistics	Optional
IS 234	Human Communication and Information Systems	Core
MT 249	Mathematical Logic and Formal Semantics	Core
IS 258	PC Maintenance	Core
IS 292	Object Oriented Programming	Core
IS 263	Database Concepts	Core
IS 281	Network Design & Administration	Core
MT 274	Numerical Analysis I	Core
IS 343	Practical Training for Computer Science II	Core
IS 262	Compiler Technology	Optional
IS 242	Introduction to Computer Graphics	Optional
IS 253	Introduction to GIS	Optional
IS 282	Software Development II	Optional
IS 254	Operating System II	Optional
Third Year		
IS 333	System Analysis and Design	Core
MT 378	Queuing Theory and Inventory Modules	Core
IS 342	Management and Control of Software Project	Core

IS 353	Implementation of Databases	Core
IS 383	Internet Application and Programming	Core
IS 334	Organization and Management of Information	Optional
130 UD	SM Prospectus 2014/15	Core
IS 391	Distributed Systems	Core
IS 335	Final Year Project	Core
IS 364	IT Security	Core
IS 363	Introduction to Artificial Intelligence	Optional
IS 352	Data Mining & Knowledge Discovery in Databases	Core
IS 373	Introduction to Computer Simulation & Modeling	Core
CS332	Object-oriented Program Design and Analysis	Optional
CS342	LAN Switching	Optional

Appendix F2: BSc. ICT curriculum–Open University of Tanzania

Course Code	Course Name	Mode of Delivery		Units	Credits
		Equiv. Lecture hours	Equiv. Practical hours		
OIT 111	Fundamentals of Information Systems	18	35	1	10
OIT 112	Computational Mathematics I	35	-	1	10
OIT 113	Probability and Statistics	35	-	1	10
OIT 114	Communication Skills for IT	35	-	1	10
OIT 115	Introduction to Computer Architecture	35	70	2	20
OIT 116	Programming in C	35	70	2	20
OIT 117	Data Communications and Networking I	18	35	1	10
OIT 118	Industrial Training I			2	20
OIT 119	Web Design and Development	35	70	2	20
OIT 211	Operating Systems	35	70	2	20
OIT 212	Systems Analysis and Design	35	70	2	20
OIT 213	Computer mathematics II	35	-	1	10
OIT 214	Object Oriented Programming with Java	35	70	2	20
OIT 215	Data Communication and Networking II	35	70	2	20
OIT 216	Introduction to Computer Security	18	35	1	10
OIT 217	Database Concepts and Design	18	35	1	10
OIT 218	Web Programming	35	70	2	20
OIT 311	Information Systems Security Management	18	35	1	10
OIT 312	Information Systems Planning and Management	18	35	1	10
OIT 313	Network Design and Administration	18	35	20	20
OIT 314	Computer Ethics and Social Cultural Implication	35	-	1	10
OIT 315	Wireless Networks	35	70	2	20
OIT 316	Final Year Project		180	3	30
OIT 317	Database Implementation and Administration	18	35	3	20